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OF THE

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EDWIN DUNKIN, F.R.S., President, in the Chair.

J. E. Evans, Principal of the Training College, Dindigal, Madras;

George Ford, B.A., Christ's College, Cambridge;

Jacob Gerhard Lohse, 68. Falsgrave Road, Scarborough;

William Irving Page, F.R.G.S., Wimbledon Common;

Captain George Parker, F.R.G.S., A.I.C.E., M.R.A.S., H.M.'s Indian Marine, Kurrachee, India;

Julien Tripplin, Belle Vue, Heathfield Gardens, Chiswick, W.;

E. L. Trouvelot, Observatoire d'Astronomie Physique, Meudon, Seine-et-Oise, France;

were balloted for and duly elected Fellows of the Society.

Observations of the Moon made at the Radcliffe Observatory, Oxford, during the year 1885, and a Comparison of the Results with the Tabular Places from Hansen's Lunar Tables. By E. J. Stone, M.A., F.R.S.

The present paper contains the Right Ascensions and North Polar Distances of the Moon as deduced from the observations made at the Radcliffe Observatory during the year 1885. These results are here compared with those deduced from Hansen's Lunar Tables on two suppositions:—

(1) That the mean times, found in the usual way from the sidereal times at mean noon given in the *Nautical Almanac*, were *not* changed in 1864.

(2) That the mean times *were* changed in 1864, in accordance with the views which I have explained in papers already communicated to the Society.

For facilities for an accurate comparison between Hansen's Lunar Tables and observations we are now indebted to the places published in the *Connaissance des Temps*.

TABLE I.

Radcliffe Observations of the Moon, 1885.

Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon. from *N.A.*	Observer.	Day, 1885.	Observed R.A.	Secs. of Hansen's R.A.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
31·28	F.B.	Jan. 12	12 22 57·55	58·79	+1·24	−1·06	+0·18	92 41 41·78	44·98	+3·20	−5·27	−2·07
31·28	R.		14 2 28·06	28·97	+0·91	−1·04	−0·13	100 18 24·99	27·67	+2·68	−4·23	−1·55
31·34	R.	Jan. 23	1 54 17·27	17·95	+0·68	−1·15	−0·47	80 25 22·40	20·37	−2·03	+4·83	+2·80
31·35	F.B.	24	...	...	...	...	...	76 51 21·77	19·65	−2·12	+4·09	+1·07
31·39	W.	Feb. 4	13 42 27·27	28·45	+1·18	−1·07	+0·11	98 38 24·84	29·06	+4·22	−4·61	−0·39
31·40	R.	5	14 32 53·29	54·19	+0·90	−1·06	−0·16	102 0 10·22	11·91	+1·69	−3·88	−2·19
31·46	F.B.	Feb. 21	3 30 54·23	54·86	+0·63	−1·23	−0·60	75 1 13·72	12·17	−1·55	+3·34	+1·79
31·47	R.	23	5 32 34·92	35·37	+0·45	−1·31	−0·86	71 48 56·41	54·87	−1·54	+0·56	−0·98
31·47	W.	24	6 35 28·49	28·95	+0·46	−1·32	−0·86	72 0 54·31	56·87	+2·56	−1·06	+1·50
31·48	R.	27	9 39 32·29	32·83	+0·54	−1·23	−0·69	79 37 31·72	36·07	+4·35	−4·91	−0·56
31·51	F.B.	Mar. 6	15 52 47·29	48·57	+1·28	−1·09	+0·19	105 50 33·05	35·34	+2·29	−2·51	−0·22
31·58	R.	Mar. 23	6 15 50·01	50·28	+0·27	−1·30	−1·03	71 53 6·41	8·23	+1·82	−0·54	+1·28
31·60	R.	27	10 13 19·95	20·50	+0·55	−1·18	−0·63	82 0 38·58	42·16	+3·58	−5·17	−1·59
31·60	F.B.	28	11 8 17·72	18·40	+0·68	−1·15	−0·47	86 14 17·33	19·03	+1·70	−5·53	−3·83

Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon, from *N.A.*	Observer.	Day, 1885.	Observed R.A.	Secs. of Hansen's R.A.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Hans.—Obs. *Uncorrected.* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
31·61	R.	Mar. 30	12 54 27·71	28·60	+0·89	−1·11	−0·22	94 51 39·57	43·90	+4·33	−5·25	−0·92
31·62	F.B.	Apr. 3	16 22 7·82	9·15	+1·33	−1·10	+0·23	106 49 33·28	36·34	+3·06	−1·96	+1·10
31·70	F.B.	Apr. 22	8 58 58·77	59·67	+0·90	−1·22	−0·32	77 6 36·53	39·12	+2·59	−4·14	−1·55
31·71	F.B.	25	11 42 46·40	47·33	+0·93	−1·11	−0·18	89 0 25·26	30·21	+4·95	−5·50	−0·55
31·72	R.	27	13 26 1·22	2·07	+0·85	−1·10	−0·25	97 17 18·44	22·55	+4·11	−4·92	−0·81
31·72	W.	28	14 17 23·76	24·72	+0·96	−1·10	−0·14	100 53 26·56	29·60	+3·04	−4·26	−1·22
31·73	F.B.	29	15 9 0·14	1·39	+1·25	−1·10	+0·15	103 54 12·71	16·30	+3·59	−3·42	+0·17
31·74	R.	May 1	16 52 58·89	59·91	+1·02	−1·11	−0·09	107 40 20·70	24·08	+3·38	−1·34	+2·04
31·82	F.B.	May 23	12 18 49·32	50·24	+0·92	−1·09	−0·17	91 50 31·61	35·72	+4·11	−5·42	−1·31
31·84	F.B.	27	15 42 19·67	21·03	+1·36	−1·10	+0·26	105 29 1·61	3·84	+2·23	−2·84	−0·61
31·84	W.	28	16 34 4·20	5·50	+1·30	−1·11	+0·19	107 17 33·11	35·57	+2·46	−1·79	+0·67
31·85	R.	29	17 26 2·29	3·36	+1·07	−1·11	−0·04	108 15 38·53	39·41	+0·88	−0·68	+0·20
31·86	W.	June 1	19 59 47·59	48·81	+1·22	−1·08	+0·14	106 0 53·39	53·90	+0·51	+2·51	+3·02
31·86	F.B.	2	20 49 33·15	34·63	+1·48	−1·06	+0·42	103 42 42·59	40·03	−2·56	+3·39	+0·83
31·96	R.	June 26	18 0 42·18	43·23	+1·05	−1·11	−0·06	108 27 22·15	21·58	−0·57	+0·02	−0·55
31·96	F.B.	27	18 52 13·31	14·60	+1·29	−1·10	+0·19	108 1 15·31	12·61	−2·70	+1·11	−1·59
31·98	W.	July 1	22 11 14·97	16·23	+1·26	−1·04	+0·22	98 45 15·72	12·83	−2·89	+4·51	+1·62

Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon. from *N.A.*	Observer.	Day, 1885.	Observed R.A.	Secs. of Hansen's R.A.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
32·06	R.	July 22	16 52 30·81	31·95	+1·14	−1·11	+0·03	107 34 12·86	13·71	+0·85	−1·52	−0·67
32·07	F.B.	23	17 44 2·67	3·90	+1·23	−1·11	+0·12	108 19 9·57	10·92	+1·35	−0·41	+0·94
32·07	R.	24	18 35 33·36	34·18	+0·82	−1·11	−0·29	108 12 30·66	29·75	−0·91	+0·70	−0·21
32·08	F.B.	25	19 26 42·98	44·24	+1·26	−1·10	+0·16	107 14 57·54	55·17	−2·37	+1·77	−0·60
32·08	F.B.	26	20 17 16·68	17·77	+1·09	−1·08	+0·01	105 29 31·33	29·86	−1·47	+2·76	+1·29
32·18	W.	Aug. 19	17 26 18·49	19·79	+1·30	−1·12	+0·18	108 0 49·10	50·71	+1·61	−0·84	+0·77
32·18	W.	21	19 9 7·97	9·06	+1·09	−1·10	−0·01	107 34 59·41	59·18	−0·23	+1·38	+1·15
32·19	F.B.	22	19 59 55·80	56·91	+1·11	−1·09	+0·02	106 7 28·04	25·71	−2·33	+2·40	+0·07
32·20	W.	24	21 39 44·93	46·01	+1·08	−1·07	+0·01	101 2 58·81	54·20	−4·61	+4·10	−0·51
32·20	F.B.	25	22 28 54·94	56·52	+1·58	−1·06	+0·52	97 38 56·83	52·39	−4·44	+4·71	+0·27
32·30	R.	Sept. 18	19 40 40·96	41·99	+1·03	−1·10	−0·07	106 43 13·90	11·82	−2·08	+2·02	−0·06
32·30	F.B.	19	20 31 2·19	3·20	+1·01	−1·09	−0·08	104 47 62·35	59·85	−2·50	+2·98	+0·48
32·31	R.	21	22 10 16·92	17·72	+0·80	−1·07	−0·27	98 58 31·26	27·76	−3·50	+4·52	+1·02
32·32	R.	25	1 31 56·86	58·00	+1·14	−1·15	−0·01	83 4 41·12	36·48	−4·64	+5·18	+0·54
32·34	W.	30	6 21 13·30	14·41	+1·11	−1·33	−0·22	71 50 33·78	34·74	+0·96	−0·41	+0·55

Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Moon. from *N.A.*	Observer.	Day, 1885.	Observed R.A.	Secs. of Hansen's R.A.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Hans.—Obs. *Uncorrected* for Error in Time.	Corr. due to Error in Time.	Hans.—Obs. *Corrected* for Error in Time.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
32·40	R.	Oct. 15	19 19 59·04	59 99	+0·95	−1·11	−0·16	107 20 49·33	48·86	−0·47	+1·59	+1·12
32·41	R.	16	20 10 31·71	32·65	+0·94	−1·09	−0·15	105 44 20·70	15·54	−5·16	+2·59	−2·57
32·45	F.B.	27	6 2 18·22	19·52	+1·30	−1·35	−0·05	71 41 20·87	21·15	+0·28	+0·10	+0·38
32·53	R.	Nov. 16	23 5 54·17	55·13	+0·96	−1·07	−0·11	95 1 10·82	5·33	−5·49	+5·09	−0·40
32·54	W.	17	23 55 0·69	1·72	+1·03	−1·09	−0·06	91 0 33·08	27·72	−5·36	+5·41	+0·05
32·54	F.B.	18	0 45 29·99	31·02	+1·03	−1·12	−0·09	86 49 37·41	34·12	−3·29	+5·52	+2·23
32·55	R.	20	2 33 28·68	29·63	+0·95	−1·24	−0·29	78 46 19·77	15·63	−4·14	+4·80	+0·66
32·65	W.	Dec. 15	0 22 38·43	39·25	+0·82	−1·08	−0·26	88 58 30·60	26·74	−3·86	+5·42	+1·56
32·68	W.	22	7 15 44·82	45·96	+1·14	−1·44	−0·30	72 8 43·60	45·79	+2·19	−1·82	+0·37
32·68	F.B.	23	8 20 54·11	55·47	+1·36	−1·40	−0·04	74 11 27·46	29·48	+2·02	−3·47	−1·45
32·70	R.	27	12 14 11·90	12·87	+0·97	−1·17	−0·20	90 12 6·04	8·74	+2·70	−5·89	−3·19
32·70	F.B.	29	13 59 0·42	1·63	+1·21	−1·14	+0·07	98 34 53·32	56·83	+3·51	−4·99	−1·48
Mean of Errors without regard to sign			...	...	s 1·023	...	s 0·236	...	...	″ 2·683	...	″ 1·139
Mean Errors for the Year			...	...	s +1·023	...	s −0·116					

Observers:—W., Mr. W. Wickham: R., Mr. W. H. Robinson; F.B., Mr. F. A. Bellamy.

TABLE II.

Radcliffe Observations of the Moon, 1885.

Errors of Longitude and Ecliptic Polar Distance. Corrected and Uncorrected for Error in Mean Time.

(Hansen—Observed.)

Day, 1885.	Errors of Longitude. Corrected.	Uncorrected.	Errors of E.N.P.D. Corrected.	Uncorrected.
	″	″	″	″
Jan. 6	+ 1·66	+ 18·33	− 2·97	− 4·41
8	− 2·34	+ 13·55	− 0 80	− 2·10
Jan. 23	− 7·50	+ 10·15	+ 0·18	+ 1·63
Feb. 4	+ 1·38	+ 17·87	− 0·95	− 2·36
5	− 2·92	+ 13·08	− 1·34	− 2·54
Feb. 21	− 8·88	+ 9·25	− 0·38	+ 0·72
23	− 12·24	+ 6·51	− 1·57	− 1·23
24	− 12·80	+ 6·73	+ 2·26	+ 2·15
27	− 9·82	+ 8·97	+ 2·79	+ 1·52
Mar. 6	+ 2·64	+ 18·58	− 0·79	− 1·66
Mar. 23	− 14·71	+ 3·92	+ 1·69	+ 1·71
27	− 9·33	+ 8·93	+ 1·85	+ 0·43
28	− 7·98	+ 10·05	− 0 80	− 2 38
30	− 3·39	+ 13·95	+ 0·42	− 1·15
Apr. 3	+ 3·45	+ 19·40	+ 0·54	− 0·11
Apr. 22	− 4·94	+ 13·39	− 0·18	− 1·20
25	− 2·70	+ 14·79	+ 0·57	− 1·00
27	− 3 76	+ 13·27	+ 0·63	− 0·87
28	− 2·35	+ 14·37	− 0·48	− 1·76
29	+ 2·15	+ 18·55	− 0·43	− 1·45
May 1	− 1·04	+ 14·91	+ 2·18	+ 1·67
May 23	− 2·86	+ 14·29	− 0·19	− 1·70
27	+ 3·53	+ 19·71	− 1·44	− 2·27
28	+ 2·80	+ 18·82	+ 0·26	− 0 31
29	− 0 56	+ 15·30	+ 0·23	− 0·03
June 1	+ 1·38	+ 17·18	+ 3 36	+ 4·01
2	+ 5·68	+ 21·52	+ 2·45	+ 3·37

Day, 1885.	Errors of Longitude. Corrected.	Uncorrected.	Errors of E.N.P.D. Corrected.	Uncorrected.
June 26	− 0″·86	+ 14″·99	− 0″·55	− 0″·57
27	+ 2·85	+ 18·64	− 1·34	− 1·04
July 1	+ 2·47	+ 18·51	+ 2·67	+ 3·94
July 22	+ 0·35	+ 16·36	− 0·72	− 1·05
23	+ 1·74	+ 17·64	+ 0·89	+ 0·86
24	− 4·12	+ 11 76	− 0·47	− 0·18
25	+ 2·36	+ 18·27	− 0·26	+ 0·29
26	− 0·15	+ 15·72	+ 1·29	+ 2·13
Aug. 19	+ 2·62	+ 18 69	+ 0 62	+ 0·52
21	− 0·28	+ 15·57	+ 1·13	+ 1·64
22	+ 0·27	+ 16·20	+ 0·13	+ 0·91
24	+ 0·31	+ 16·56	− 0·43	+ 0·82
25	+ 7·10	+ 23·52	+ 3·08	+ 4·48
Sept. 18	− 0·98	+ 14·98	− 0·23	+ 0·44
19	− 1 25	+ 14 85	+ 0·18	+ 1 17
21	− 4·11	+ 12·34	− 0·46	+ 0·92
25	− 0·34	+ 17 52	+ 0·45	+ 1·91
30	− 3·13	+ 15 92	+ 0·67	+ 0·36
Oct. 15	− 2·43	+ 13·57	+ 0·80	+ 1·40
16	− 1·57	+ 14·42	− 2·98	− 2·12
27	− 0·71	+ 18·57	+ 0·38	+ 0·20
Nov. 16	− 1·36	+ 15·36	− 1·00	+ 0·48
17	− 0·85	+ 16·31	− 0·31	+ 1·23
18	− 2·12	+ 15·50	+ 1·53	+ 2·98
20	− 4·27	+ 14·60	− 0·70	+ 0·43
Dec. 15	− 4·20	+ 12 84	− 0·11	+ 1·33
22	− 4·21	+ 16·46	+ 0·92	+ 0·05
23	− 0·89	+ 19·60	− 1·28	− 2·52
27	− 4·02	+ 14·44	− 1·73	− 3·31
29	+ 0·46	+ 18·10	− 1·75	− 2·92
Mean of Errors without regard to sign	3″·459	15″·144	1″·066	1″·556
Mean Errors for Year	− 1″·873	+ 15″·144	...	...

TABLE III.

Observations of the Moon, 1862 *to* 1885.

Mean Errors of Longitude. Uncorrected and Corrected for Error in Mean Time.

Year.		Errors of Longitude. (Hansen—Observed.) *Uncorrected.*	*Corrected.*	Year.		Errors of Longitude. (Hansen—Observed.) *Uncorrected.*	*Corrected.*
		″	″			″	″
1862	Greenwich	−2·829	−2·829	1874	Greenwich	+ 9·294	+0·561
1863	„	−1·606	−1·606	1875	„	+ 9·867	+0·365
1864	„	+0·121	−0·814*	1876	„	+ 9·800	−0·509
1865	„	+1·271	−0·220	1877	„	+ 9·234	−1·898
1866	„	+2·142	−0·217	1878	„	+ 8·219	−3·603
1867	„	+3·480	+0·357	1879	„	+ 9·631	−3·124
1868	„	+4·117	+0·280	1880	„	+10·265	−3·245
1869	„	+4·277	−0·352	1881	„	+10·622	−3·791
1870	„	+4·828	−0·657	1882	Radcliffe	+12·927	−2·508
1871	„	+6·955	+0·435	1883	„	+14·615	−1·547
1872	„	+7·309	+0·097	1884	„	+14·645	−1·907
1873	„	+8·239	+0·200	1885	„	+15·144	−1·873

Radcliffe Observatory, Oxford,
1886, *January* 6.

On Photographs of a new Nebula in the Pleiades, and of Saturn.

(*Letter to the President, from MM. Paul and Prosper Henry.*)

Nous avons reconnu à l'aide de la photographie, l'existence d'une nébuleuse nouvelle dans les *Pléïades*. Cette nébuleuse est voisine de l'étoile Maïa, qu'elle contourne, en partie, et d'où elle paraît s'échapper.

Elle affecte une forme spirale bien caractérisée et son étendue est de 2′ ou 3′ environ.

Il nous a été possible d'obtenir l'image de la nébuleuse sur 3 épreuves différentes: le 16 Novembre et les 8 et 9 Décembre derniers.

Nous ajouterons que, jusqu'à présent, nous n'avons pu l'apercevoir dans nos télescopes.

Nous avons l'honneur de vous adresser, Monsieur le Président, une reproduction agrandie, du négatif original, montrant la nébuleuse avec les étoiles environnantes.

Nous nous sommes permis d'y joindre quelques images de *Saturne* obtenues dernièrement.

Observatoire de Paris,
le 5 *Janvier,* 1886.

* Here change in the unit of time took place.

Photographic Maps of the Stars. By Isaac Roberts.

The letter from Admiral Mouchez, which was published in the *Monthly Notices* for November, shows the necessity for making known what has already been done in the direction he indicates.

In the year 1883 I made experiments on photographing stars with ordinary portrait lenses varying in aperture between three-eighths of an inch and five inches. The lenses were made by English, American, and French opticians. One of two inches aperture, by Lerebours et Secretan, gave the best results, and I adopted it as a standard for comparing the others. The comparisons were made by attaching two cameras to the declination axis of my 7-inch equatorially mounted Refractor, by Cooke, and taking simultaneous photographs of some well-known group of stars under precisely similar conditions.

The photographic plates were selected with regard to uniformity, and sometimes a plate would be cut in two, one-half being exposed in each camera under similar conditions.*

The result of these experiments and comparison with Mr. Common's great photograph of the nebula in *Orion* was that I gave Mr. Howard Grubb an order to make me a 20-inch silver-on-glass reflector with 100 inches focal length; the photographs to be taken directly in the focus of the mirror, to obviate any loss of light by a second reflection. The photographic telescope to be mounted on the same declination axis as the 7-inch Refractor, one being the counterpoise to the other.

Both telescopes move independently in Declination, but the motion in Right Ascension is common to both.†

The duplex telescope was mounted in March 1885, and after determining the size of the photo-field, the amount of overlap required, the time of exposure and preparing a method for easily registering the negatives, I was ready on May 1 to commence the regular work of taking photographs of the stars in the northern hemisphere, commencing at the Pole.

The size of the field which I adopted is 2° in Declination, and about $1\frac{1}{2}$° in Right Ascension, thus allowing sufficient margin for overlap. The time of exposure is fifteen minutes of clear sky, the photo-field being on or near the Meridian, and an allowance in time made for any mistiness or clouds which may arise when taking a photograph.

* On some recent experience in photographing stars with ordinary cameras and lenses by the author. *Proceedings* of the Liverpool Astronomical Society, vol. ii. p. 41.

† To Dr. Huggins is due the credit for devising this most ingenious, simple, and useful mode of mounting a reflector and refractor side by side; and the skill of Mr. Howard Grubb is well shown in the arrangements of the instrument to perform well the objects intended.

The frequent atmospheric changes that occur in our climate are important elements to be considered in fixing the time for exposing the photographs, and under this head the suggestion of Admiral Mouchez, for an exposure of one to three hours, if adopted, would make the progress of the work extremely slow.

Fifteen minutes of clear sky can often be utilised by keeping a good look-out, but an hour or three hours are rarely available.

Stars of small magnitude can be photographed by my reflector in fifteen minutes, but it would be misleading to name the photographic magnitudes by those which have been determined by eye-observations until comparisons have been made between large numbers of stars and the errors consequent upon the focussing of the instrument, the varying sensitiveness of the plates, the duration of the exposure, the varying actinism caused by moisture in the atmosphere, the varying density of image obtained in developing, &c., have been eliminated or reduced to a constant factor.

At present I will only refer to the experimental plates on which *Polaris* has been photographed when near the upper Meridian. Between September 15 and December 15, 1885, seventeen photographs have been taken with exposure of each plate between *one second* and *thirty-two minutes*. On some of them the *companion* is photographed faintly in *four seconds*, whilst on others it does not appear under an exposure of *one minute*, and on one plate it does not appear on exposure up to *sixteen minutes*' duration. I must defer the discussion of this subject to another occasion; but it is evident that the interpretation of photographs, as regards star colour and magnitude, should be done under due sense of the difficulties here named.

The diagram shows the form of record which I keep of the photographs.

The upper numerals in each space correspond with those marked on the film. The lower numerals are the Right Ascensions, and the degrees (84° to 90°) are the Declinations at the middle of each plate. A cross is marked upon each space after the photograph is taken and examined, and if more than one is taken of any space, a dot is inserted to record each additional photograph.

The Polar plate is a circle 2° in diameter; then concentrically with it are zones 2° in Declination, and of the widths respectively shown in Right Ascension, which, together with the convergence of the Meridians, give a large overlap for tracing stars on contiguous plates.

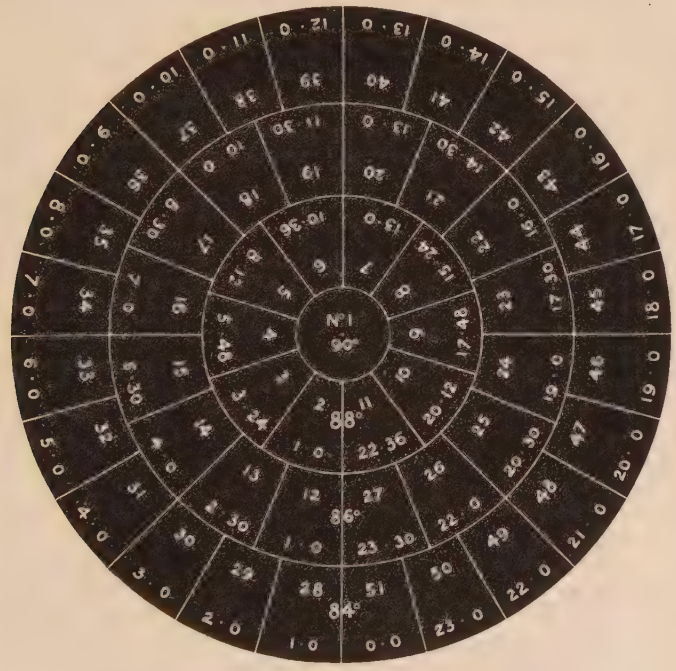
Each plate is marked on the film with the hour it was taken, the day, the month, the year, and the number, corresponding with that on the index chart. A book is also kept with these particulars in vertical columns, and remarks upon the state of the sky are recorded.

The following is a list of the photographs which have been taken up to December 29, 1885:—

Dec. 90° = polar circle.

Dec.	87	to	89	– R.A.	h 1	m 0	to	h 9	m 24	and	h 11	m 48	to	h m 24 0
„	85	„	87	– „	1	0	„	24	0 = the zone complete.					
											h	m		h m
„	83	„	85	– „	1	30	„	8	30	and	15	30	to	24 0
„	81	„	83	– „	1	0	„	6	37	„	15	37	to	24 0
„	79	„	81	– „	1	0	„	7	18	„	17	0	to	24 0
„	77	„	79	– „	1	0	„	7	56	„	18	0	to	24 0
„	75	„	77	– „	1	0	„	7	15	„	20	15	to	24 0
„	73	„	75	– „	2	18	„	9	12	„	20	24	to	24 0
„	71	„	73	– „	2	50	„	6	50					
„	69	„	71	– „	4	24	„	5	21					

The negatives are stored in grooved wood boxes, each forming a sliding drawer, and containing 100 plates.



Part of chart for registration of star photographs.

The register number on the chart, in the book, and on the box refer to the number marked on the film of the negative.

How the negatives are to be reduced, and the information

which they contain is to be utilised astronomically, are questions which are constantly present with me, and the difficulties in answering them cannot be fully realised but by those who have seriously tried, and I may here enumerate some of them.

Most of the photographic plates have small specks in the film, many of which look like stars, and are difficult to distinguish from stars even when viewed through a microscope. Dr. Gill, at the Cape Observatory, meets the difficulty by taking two photographs successively of the same field, giving to each an exposure of one hour; but this makes the work almost Herculean, especially where clouds generally cover the sky. Another plan is to let the telescope run a few seconds of arc in Right Ascension during the exposure of the plate. This, again, is equivalent to two or more exposures of the stars upon different points of the film, and make what would be called one hour's exposure in reality only an exposure of some fraction of an hour. Admiral Mouchez suggests three exposures of an hour each, thus making a triangular figure with three positions of the same star. The objections to this are—great loss of time, confusion in positions of close stars, causing the discs of some to overlap others, and leaving the dirt specks still competing for recognition as stars.

Long exposures of the plates add to the difficulty in discriminating between specks and stars, by making the star discs appear large and black to the margins; but with a short exposure the small star discs show fainter, and often the atmospheric glare forms a halo round the star, which under the microscope materially assists in distinguishing between stars and specks.

All stars below, say, the 7th magnitude, require the aid of a lens or microscope to see them, but I do not find great difficulty in manipulating the light, the plate, and the microscope in such a way that the stars can with considerable certainty be distinguished from specks on the photographs taken with the 20-inch Reflector and exposure of fifteen minutes.

These statements refer only to viewing the stars by the aid of a microscope, and do not apply to printing them direct from the negatives, which in some form must be done before star photography can be appreciated and generally utilised as an astronomical pursuit. This is an additional problem, to those already referred to, that yet has to be solved.

The work of first importance is to secure good photographs of all stars down to the smallest magnitude practicable in as short a time as possible. They will in all future time be available for comparison with photographs which can at leisure be taken by large instruments for special researches.

The chart upon which I am engaged will be upon a scale twice the size of *Argelander's*, and, with an exposure of fifteen minutes for each plate, will contain a much larger number of stars than are shown on the *Atlas des Nördlichen Gestirnten Himmels.*

I submit a few negatives as samples of the general character of those already taken. Amongst them are plates of *Polaris*—*Andromeda* with the *Nova*—the *Pleiades* and *Nebula* in *Orion*.

On the Orbit of γ Coronæ Australis. By J. E. Gore.

The duplicity of this interesting binary star was discovered by Sir John Herschel at the Cape of Good Hope. Elements of the orbit were published by Captain Jacob in the year 1855 (*Monthly Notices*, R.A.S., vol. xv. p. 208), and he found a period of 100·80 years, with periastron passage, 1863·08. Some years since Prof. Schiaparelli published elements in No. 2,073 of the *Astronomische Nachrichten*, in which he assigns a period of 55·582 years, with an eccentricity of 0·6989, and periastron passage 1882·774. These elements were corrected by Mr. Downing (*Monthly Notices*, May 1883). As there are considerable differences between the elements found by Captain Jacob and Prof. Schiaparelli, particularly in the length of the period, I determined to make a new computation of the elements, and details of the results I have arrived at may be of interest.

The orbit was computed by a graphical method, in which the dimensions and position of the real ellipse are derived from those of the apparent ellipse by means of Thiele's harmonic ellipse. This latter ellipse being the orthogonal projection of the harmonic circle on a plane perpendicular to the line of sight, its major axis is of course equal in magnitude to the *latus rectum* of the real ellipse, and its angle of eccentricity is the angle of inclination of the plane of the real ellipse to the plane of projection on the background of the heavens. Thus the magnitude and position of the real orbit can be fully determined.

The following are the observations from which I have computed the elements. They have been corrected for precession, by the usual formula, to the epoch 1880·0:—

γ Coronæ Australis.

Angles and Distances: Angles reduced to 1880.

R.A. 1880, $18^h\ 59^m = 284° 45'$.

Dec. S. 37° 18′.

Correction $= 0°·0055 \sin \alpha \sec \delta = -0°·007$ per annum.

t	θ'	θ	r	Observer.
1834·47	37°·1	36°·78	2″·66	Sir John Herschel.
1835·55	36·8	36·5	2·66	„ „
1836·43	34·5	34·2	2·66	„ „
1837·43	32·7	32·4	2·66	„ „
1858·203	343·42	343·27	1·53	Jacob.
1863·836	318·1	318·0	1·25	Powell.
1875·65	257·4	257·37	1·45	Schiaparelli.

t	θ'	θ	r	Observer.
1876·6	253°·1	253°·1	1″·67	O. Stone.
1878·49	242·6	242·6	1·36	,,
1879·69	240·0	240·0	0·87	Burnham.
1880·4	233·1	233·1	1·15	Russell.
1880·7	232·4	232·4	1·32	,,

A table of interpolated angles and epochs was then formed, and the apparent ellipse drawn by the method described in the *Handbook of Double Stars*, by Messrs. Crossley, Gledhill, and Wilson. The elements of the real ellipse were then derived from the apparent ellipse, as above described. The elements thus found are as follows :—

Elements of γ Coronæ Australis.

Position of node	$\Omega = 45° 25'$
Inclination	$\gamma = 47° 26'$
Position of periastron	$\lambda = 141° 0'$
Eccentricity	$e = 0·322$
Period in years	$P = 81·78$
Periastron passage A.D.	$T = 1886·53$
Semi axis major	$a = 1''·885$.
Mean annual motion	$\mu = -4°·402$

These elements are of course only provisional, and further observations during the next ten years will be required before an accurate computation of the orbit can be made.

The shape of the apparent orbit and the elements found above somewhat resemble those of 70 *Ophiuchi*.

A comparison was made between the positions computed from the graphical construction for the epochs of observation, and the observed measures, with the following results :—

Epoch	Position Angles. Observed.	Computed.	Difference. O−C.	Distances. Observed.	Computed.	Difference O−C.
1834·47	36°·8	37°·6	−0·80	2″·66	2′·33	+0″·33
1835·55	36·5	35·6	+0·90	2·66	2·33	+0·33
1836·43	34·2	33·8	+0·40	2·66	2·34	+0·32
1837·43	32·4	31·8	+0 60	2·66	2·34	+0·32
1858·20	343·27	342·65	+0·62	1·53	1·66	−0·13
1863·83	318·0	321·3	−3·30	1·25	1·47	−0·22
1875·65	257·4	259·0	−1·60	1·45	1·39	−0·06
1876·60	253·1	253·6	−0·50	1·67	1·39	−0·28
1878·49	242·6	243·7	−1·10	1·36	1·40	−0·04
1879·69	240·0	238·0	+2·0	0·87	1·39	−0·52
1880·40	233·1	234·4	−1·3	1·15	1·37	−0·22
1880·70	232·4	233·9	−1·5	1·32	1·37	−0·05

The computed angles have been corrected for the effect of precession.

It will be seen that there is a fair agreement in the angles but not in the distances. In one of Sir J. Herschel's measures at the Cape, and to which he assigns greater weight than the others, he gives the distance as 2″·40, agreeing fairly with the computed distance at that epoch.

It may be mentioned that as the major axis of the orbit is not far from the line of nodes, we see it nearly of its natural length, as in the case of the binary *η Coronæ Borealis*.

For the calculation of an ephemeris, the following formulæ are derived from the elements:—

(1) $u - 18°{\cdot}45 \sin u = -4°{\cdot}402\,(t - 1886{\cdot}53)$.

(2) $\tan \frac{1}{2}v = 1{\cdot}396 \tan \frac{1}{2}u$.

(3) $\tan (\theta - 45°\ 25') = 0{\cdot}6764 \tan (v + 141°\ 0')$.

(4) $\rho = 1''{\cdot}885\,(1 - 0{\cdot}322 \cos u) \cdot \dfrac{\cos (v + 141°\ 0')}{\cos (\theta - 45°\ 25')}$.

Where u is the eccentric anomaly, and v the true anomaly for the time t, θ the required position angle, and ρ the distance.

From these formulæ I have computed the following short ephemeris.

Date.	Position Angle.	Distance.	Date.	Position Angle.	Distance
	°	″		°	″
1886·0	200·7	1·20	1891·0	154·9	0·94
1886·53	196·7	1·13	1892·0	141·5	0·94
1887·0	193·0	1·08	1893·0	130·4	0·96
1888·0	184·3	1·04	1894·0	120·2	1·01
1889·0	174·7	0·99	1895·0	110·9	1·07
1890·0	164·9	0·96	1896·0	102·7	1·14

I may add that the above calculations were completed before I read Mr. Downing's paper. I find that the additional observations given by him all lie close to my interpolating curve, so that my results would not have been much altered had these additional observations been included.

On a new Variable Star of Short Period. By J. E. Gore.

I have lately discovered that the star 10 (Flamsteed) *Sagittæ* is an interesting variable of short period. I first suspected variation in this star in October 1879, when I found it fainter than 11 *Sagittæ*, although it was rated one-third magnitude brighter by Heis. I did not pay much further attention to the star until October 1885, when I again began to observe it, and a few consecutive fine nights in November showed that the star was certainly variable, with a period of 8–9 days. My observations have been fully confirmed by the Rev. T. E. Espin and Mr. E. F. Sawyer. The variation is approximately from 5·6 mag. to 6·4 mag. in the scale of the *Durchmusterung*, and the period about $8\frac{1}{2}$ days.

The following are all my observations to end of December 1885.

The comparison stars are:—

	Mag.	
11 Sagittæ	5·8	In *Durchmusterung*.
9 Sagittæ	6·6	
DM. + 16°, 4086	7·0	

Observations of 10 *Sagittæ*.

	h	m	Mag.
1876 Dec. 14			5·6
1879 Oct. 7			6·3
1882 Nov. 2			6·0
1884 Sept. 21			6·4
1885 Oct. 15			6·0
31			5·7
Nov. 4	11	0	6·0
9			5·7
14	8	22	6·4
14	10	55	6·4
15	6	15	6·3
15	10	15	6·3
16	6	0	6·0
16	10	35	5·9
17	6	0	5·7
18	6	10	5·8
18	9	40	5·8
21	5	53	6·1

	h. m.	Mag.	Mag.
Nov. 28	8 0	5·9	5·6 Espin
29	6 50	6·0	
30	5 30	6·2	6·2 „
Dec. 1	5 50	6·4	6·4 „
2	5 55	6·4	
4	5 20	5·6	
5	6 0	5·7	5·5 „
7	5 50	5·9	6·1 „
8	—	—	6·2 „
9	7 30	6·35	6·4 „
10	—	6·4	6·25 „
11	—	—	6·0 „
13	6 25	5·7	5·45 „
14	—	—	5·6 „
15	—	—	6 0 „
16	5 50	6·0	
16	7 25	6·1	
16	8 25	6·1	
17	—	—	6·4 „
22	5 55	5·8	
22	7 45	5·7	
27	6 50	6·2	
28	6 5	6·0	

Having plotted the observations in 1885 on square-ruled paper and drawn the light curve, I find the following dates of maxima and minima :—

Maxima.	Minima.
1885 Oct. 31·3	1885 Nov. 14·3
Nov. 9·3	23·1
17·6	Dec. 1·9
Dec. 3·8	10·0
13·3	18·0
22·3	

Treating the maxima by the method of least squares in the usual way, I find the following provisional elements :—

Period = 8·578 days

Mean epoch = 1885, Nov. 26·10

Variation 5·6 mag. to 6·4 mag.

Increase of light quicker than the decrease.

The minima treated in the same way give the following:—

Period = 8·43 days
Mean epoch = 1885, Dec. 1·46.

On the New Star in Orion. By J. E. Gore.

I first saw this star with a binocular field-glass on December 13, 1885, at 9.20 P.M., Dublin mean time. My attention was attracted to it by its very reddish colour, and its absence from Harding's charts.

When first seen the star was slightly but *distinctly* brighter than χ^2 (57) *Orionis*—about 0·15 magnitude. It has since slowly diminished in brightness, and the following are my estimates of its magnitude, the comparison stars being

	Mag.
χ^2 Orionis	6·3
Lalande 11088	6·6
DM. 20°, 1156	7·2

Observations of Nova Orionis.

		Mag.	
1885	Dec. 13	6·15	Clear sky.
	14	6·4	Drifting clouds.
	16	6·3	Strong moonlight.
	22	6·6	,, ,,
	25	6·9	,, ,,
	27	6·9	Clear sky; no moon.
	28	7·0	,, ,,
1886	Jan. 6	7·3	
	13	7·5	
	16	7·7	

Continuous observation was prevented by cloudy weather.

On a New Star in the Constellation of Orion. By Ralph Copeland, Ph.D.

On December 13, 1885, Mr. J. E. Gore, of Beltra, Ballysodare, Ireland, observing with a binocular, found a reddish star about 6 mag. some 20′ following χ' (54) *Orionis*. The star not being given by Harding, Lalande, Heis, or Birmingham, Mr. Gore suspected that it was either a "new star," or a remarkable variable. Mr. Gore's attention was attracted to it by its red colour and its absence from Harding's atlas.

On the receipt of these particulars from Mr. Gore on December 16, the star not occurring in the *Durchmusterung*, or, with certainty, in any of the usual catalogues, a telegram was immediately sent to Cambridge, U.S., and on the following day a circular giving a short account of the star was distributed by post. On the night of December 16 the star had been recognised by its orange-red colour, its place approximately laid down and the spectrum examined with a prism in front of the eyepiece as well as with a low-power spectroscope. Comparisons with neighbouring stars gave a magnitude of 6·3, from which it seems to be slowly declining, if reliance can be placed in the slight change in the following estimates :—

	Mag.		Mag.
Dec. 22	6·5	Dec. 26	6·5
24	6·5	29	6·6
25	6·5	Jan. 2	6·6

A prompt telegraphic response from Harvard College gave the brightness as 6·0 mag. on December 16.

At the first glance the spectrum was seen to be a specially beautiful one of type III., but it was not until a powerful compound prism was brought to bear on it on the 17th that its extraordinarily marked character was fully realised.

The large number of details thus rendered visible are shown in the following table, which gives the wave-lengths as they resulted from each set of observations, with the mean values.

Measures of the Spectrum of the New Star in Orion.

Description of line, band, &c.	Dec. 17.		Dec. 18.		Dec. 26.			Means. m.m.m.
Spectrum begins	669 ±				671 ±			670 ±
Dusky band begins	626·9				627·1			627·0
„ „ ends	616·4				613·5			615·0
					611·0			611·0
Maximum of great bright band								595·5
Dusky band begins	597·2	593·7						
„ „ ends	587·0	585·4				583·9		585·4
Almost a bright line					584·1			584·1
Maximum in bright band	577·1							577·1
Brighter from					559·2			559·2
To the beginning of a dimmer part at					549·0			549·0
Sharp edge towards the red of a bright band; brightest part of the spectrum	544·1	542·7	542·6		541·7			542·8
The band fades away at					520·4			520·4
Dark line: darkest part of spectrum...			518·9	517·0	519·0	to	516·8	517·9
Very bright line: beginning of band	517·4	515·3	515·6		516·2		516·3	516·2
Second bright line	515·7	513·1 512·4						513·7
The band fades away, ending at	500·4		504·4		503·2			502·7
Dark line			495·5					495·5

Description of line, band, &c.	Dec. 17.	Dec. 18.	Dec. 26.	Means m.m.m.
Bright line: beginning of band	494·4	493·9	494·8	494·4
Second bright line	492·3			492·3
The band fades to invisibility at	484·5		485·9	485·2
Bright line; fairly visible Isolated bright line, just discernible }	478·0		477·6	477·8
Bright line; fairly visible	472·3		472·2	472·2
Fades off to			466·2	466·2
Faint luminous band			456·2	456·2
End of spectrum	450 ±			450 ±

The sketch gives an idea of the relative degree of brightness of the various parts of the spectrum.

The spectrum is unmistakeably of the third type, of which *α Orionis* is the brightest member. But in this star the *bright bands* are so strikingly developed that they form the most salient parts of the spectrum. Adopting this view, an examination of the preceding numbers and the descriptions of the bands, &c., to which they refer, reveals the startling fact that this spectrum is not so much a continuous one, interrupted by dark lines and dusky bands, as *a not very luminous spectrum upon which a series of bright bands are superposed*. One of the bright bands, that beginning with the "very bright line," w.-l. 516·2 m.m.m., is most readily identifiable as the great hydro-carbon band seen in the spectrum of every comet that has been examined under favourable circumstances. This identification is strongly supported by the second bright line 513·7, which is also found both in hydro-carbon and cometary spectra. It is, however, on bringing the spectra of the star and of the blue flame of a spirit-lamp at the same time into the field of the spectroscope that their exact agreement becomes most evident. For not only do they agree perfectly in wave-length and in beginning with two plainly distinguishable bright lines, but also in the delicate gradations of light by which they similarly fade away towards the violet, thus forcing the extreme probability of a common origin upon the observer.

But the presence of luminous lines does not rest on this single band, for the second cometary and hydro-carbon band, which has its bright edge at w.-l. 472·9 (Hasselberg, *Ueber die Spectra der Cometen*), is also found in the new star's spectrum at w.-l. 472·2.

Of the three other luminous bands agreeing with the coal-gas spectrum, which were all measured at Dun Echt in that of Comet 1881, III.,* two lie beyond the limit to which I have yet traced the spectrum of this star, and the third, falling between w.-l. 563 and 534 in a bright and otherwise difficult part of the spectrum, has not yet made its possible presence evident.

This leaves the origin of the bright bands beginning at 542·8 and 494·4 an open question; but, excepting their general appearance, there is no reason why they should be due to the same substance as the great band at 516·2. On the other hand, the presence of the bright hydro-carbon bands in a spectrum of type III. removes any difficulty there may be in accepting Secchi's conclusion that they appear in a reversed (dark) form in spectra of type IV.

The position of the new star was determined by Dr. L. Becker with the Dun Echt transit circle of 8·6 ins. aperture, as below, the places being based on the catalogue of the *Berliner Jahrbuch*.

* *Copernicus*, vol. ii. p. 227.

1885.	Mean R.A.	Mean Decl.
	h m s	° ′ ″
Dec. 17	5 48 59·52	+20 9 13·7
18	59·49	14·2
22	59·49	14·5
24	59·56	15·9
26	59·55	13·9
Mean place 1885·0:	5 48 59·52	+20 9 14·4

On January 2, 1886, the Rev. S. J. Johnson wrote to me there was a star in Bode's Maps (1782) near the *Nova*, but which is not in the larger or smaller maps of the S.D.U.K. or any other atlas in his possession. In the description of the *Uranographie* Bode refers the star to Hevel, who gives it in the *Prodromus Astronomiæ*, on pp. 228 and 296, as "in Clavâ intermedia." It is duly entered in map Qq of the *Firmamentum Sobiescianum*,* and forms No. 1064 of Baily's edition of Hevel's Catalogue in vol. xiii. of the Society's *Memoirs*. Respecting it, Baily says: "I cannot find any star that will accord with this position; neither can I discover any observations of it in the *Machina Cœlestis*. It is not in the Index to that work. The two other neighbouring stars, which are designated by Hevelius as 'In clavâ præcedens' and 'sequens,' were observed on April 18, 1667."

Dr. L. Becker, on reducing all three stars from 1660 to the date of the *Durchmusterung*, finds:

		1855·0. Hevel.	Durchmusterung.	H−D.M.
		h m s	h m s	s
In Clavâ præcedens	α	5 45 54	5 45 48	+6
	δ	+20° 15′·2	+20° 14′·8	+0′·4
		h m s		
In Clavâ intermedia	α	5 51 30		
	δ	+20° 15′·1		
		h m s	h m s	s
In Clavâ sequens	α	5 55 29	5 55 19	+10
	δ	+20° 7′·5	+20° 8′·4	−0′·9

The Meridian observations of the new star give:—

			Hevel−Nova
		h m s	m s
Nova Orionis, 1855	α	5 47 13	+4 17
	δ	+20° 8′·7	+ 6′·4

* The Dun Echt copy of this atlas bears the autograph "J. E. Bode. 1774, 10/24, Berlin."

If Hevel did really observe the same star as Mr. Gore there must be an error of 1° in Hevel's observation. Hevel calls the star 7 mag., but there is no star of that size either in the Bonn maps or in the heavens with which it can be identified, without the assumption of some error.

Flamsteed measured the places of the quadrilateral of stars formed by 54, 57, 61, and 62 *Orionis* with the sextant on February 20, 1680, but makes no mention of any star inside the group.* The star does not occur in Sufi or any of the ancient catalogues.

Dun Echt Observatory:
1886, *January* 7.

Observations of the Spectrum of Nova Orionis made at the Royal Observatory, Greenwich. By E. W. Maunder.

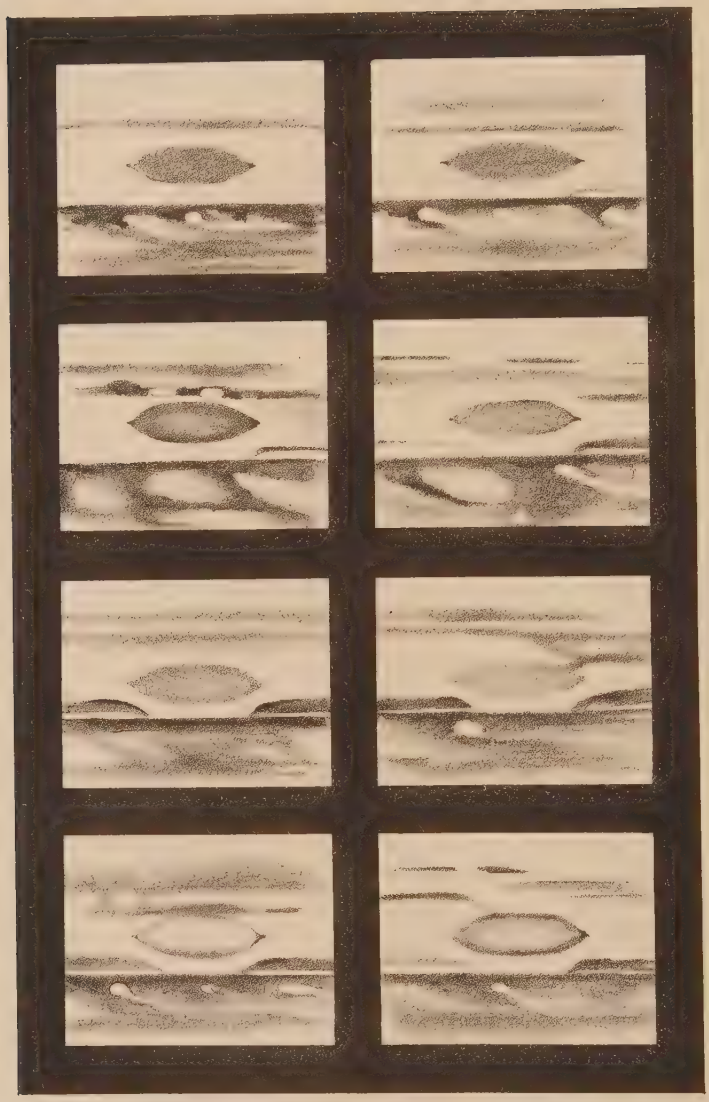
The spectrum of the new variable, discovered by Mr. Gore near χ' *Orionis*, was examined on the evening of 1885, December 29, with the "half-prism" spectroscope reversed, and a train of one "half-prism," giving a dispersion of about 5° from A to H. A magnifying power of 28 was used upon the viewing telescope. A cylindrical lens was employed before the slit, which was not quite sufficiently narrow to separate the bright lines of the magnesium spectrum which correspond to b_2 and b_4, Slit width=0·00688 in. corresponding to about 7″ of arc.

The spectrum is an exceedingly pronounced example of Secchi's third type. The dark bands are *very* dark; the bright zones or interspaces *very* bright, and with a low dispersion would undoubtedly present the appearance of bright lines. With the dispersion employed, however, no bright lines could be detected, nor was any local irregularity of brightness, which could reasonably be suspected to be a bright line, seen anywhere; notwithstanding that, as just stated, the brilliance of the bright zones, especially close to the sharp edges of the dark bands, was very striking.

Four dark bands were very conspicuous. Adopting the numeration employed in the observations of β *Pegasi*, made on 1876, October 18, and published in the volume of Greenwich Observations for 1876, these were Bands IV., V., VI., and VII. The following three measures were obtained of the sharp, more refrangible edge of Band VI. (Band 7 in Dunér's nomenclature):—

	Wave-length. Tenth-metres.
	5167·76
	5170·29
	5170·57
Mean ...	5169·54

* *Hist. Cæl.*, i. p. 81.



Jupiter's Red Spot and the region near.

	h.	m.		h	m
1. 1880 Nov. 19.	9	23.	2. 1881. Sep. 28.	13	11.
3. 1881 Dec. 7.	10	40.	4. 1882. Oct. 30.	16	10.
5. 1883 Oct. 15.	15	37.	6. 1884. Feb. 6.	9	29.
7. 1885 Feb. 25.	12	50.	8. 1885. May 9.	8	8.

10 inch reflector, powers 212 and 252.

W.F. Denning del
W. H. Wesley lith

West, Newman & Cº imp

Bands IV. and V. were identified beyond any doubt by their proximity to the line λ 5527, of the magnesium spectrum and Band VII. (Dunér's Band 8), by its neighbourhood to the double line of air λ 5003, and it was clear that they occupied their usual places. These were measured in the spectrum of *β Pegasi*, on the occasion above referred to, as λ 5610, λ 5450, and λ 4953. The dark line on Band VI., the wave-length of which was measured in the spectrum of *β Pegasi* as λ 5272 (Dunér's Band 6), was not identified, but Band VI. was so broad that it probably embraced this line or sub-band within its limits. A band was also seen at D, without doubt Band II., λ 5869 (Dunér's Band 3), and another beyond F, probably Band VIII., λ 4761 (Dunér's Band 9). Band I., λ 6169 (Dunér's Band 2), was only just suspected. The spectrum was not traced far enough for bands to be detected beyond these, either towards the red or the violet. Some feeble bands or lines were suspected between Bands V. and VI., but none of the great bands were resolved into lines. The *breadth* of the great bands seemed to be about the same as usually observed in stars of this type. The dark line or narrow band at λ 5272 is often confused with Band VI., and the breadth of the latter was not greater than would result from this cause.

Royal Observatory, Greenwich:
1886, *January* 6.

Changes in the Red Spot on Jupiter. By W. F. Denning.

It may be interesting to record and compare some of the visible changes which have occurred in the aspect of this remarkable formation; and with this end in view I send the accompanying drawing of the appearances observed in my 10-inch Reflector on several occasions since 1880.

A brief *seriatim* description of the most noteworthy features and variations of the spot and region near will be sufficient for the present purpose. A discussion of the phenomena in their physical relations would only be premature pending the further accumulation of records. In each case the spot was delineated at mid transit.

1. 1880, Nov. 19, $9^h\ 23^m$.—Red spot very dark and definite in outline with minute black speck at following end. N. of the centre the white equatorial spot is seen, the two markings being in conjunction.

2. 1881, Sept. 28, $13^h\ 11^m$.—The spot very red and conspicuous, with small black marks at E. and W. extremities. Immediately N., and slightly preceding, the white equatorial spot is observed with its normal light-trail running to N.E. and confused with other irregularities on the equator. N. of the following end a very curious narrow, curved belt, of red colour,

is traced emerging from the great S. belt and running parallel with it far to E. This feature was also visible in 1880, Sept., though it afterwards faded, and a detail of very similar character and position is figured by Mr. Gledhill near his ellipse of 1869–70.

3. 1881, Dec. 7, $10^h\ 40^m$.—Red spot evidently fading in the central part, though the elliptical outline remains equally bold, especially on the N. side, where it abuts great S. belt. The black specks at the longitudinal limits of the spot are still very obvious, and the bent belt N. of the following end now appears much plainer than before. Several large irregular white patches lie near equator, and there is a singular alternation of oval white and dark markings on a belt closely outlying the spot on its S. side.

4. 1882, Oct. 30, $16^h\ 10^m$.—The spot very much fainter generally, though still a fairly prominent object on the planet's surface. The decadence has chiefly affected the central region; the dark ends are still apparent, and the integrity of form is not disturbed. The bent belt N. following has further developed: it is broader, and the red colour more conspicuous. It has now extended itself so much as to completely environ the planet, and where it comes up to the N. preceding end of the red spot, it suddenly dips N., and merges into the great S. belt, so that the appearances near the spot's following end are here repeated, and the effect is a symmetrical jointure of the two belts relatively to the red spot. The white equatorial spot is shown N. of the following side, but the variegated belt just S., seen in Dec. 1881, is gone.

5. 1883, Oct. 15, $15^h\ 37^m$.—Red spot very faint and apparently of nearly uniform tone. The bent belt has now become a very prominent feature, and forms a basin in which the red spot rests, though perfectly detached. Indeed, the region separating them is very bright, as if the lucid zone in the same latitude as the red spot ran N. to avoid contact. The shoulders of the bent belt are very dark, but there is rather an absence of other detail.

6. 1884, Feb. 6, $9^h\ 29^m$.—Spot very faint, though under good definition it is well seen. A striking feature now arrests the eye in the form of a narrow dark belt which is actually connected with the spot on S. following side. Though the N. belt has avoided the spot so persistently, here is a belt curving down right into the spot! The fact is very interesting, and goes far to prove that the bright belt, in curving down to avoid commingling with the red spot, carries the faint S. belt with it, and thus reproduces a parallel formation to the bent belt on the spot's N. following side. This junction of the belt and spot was observed in Jan. and Feb. 1884, by several other observers independently. The sketch shows a white equatorial spot (though not the one so frequently observed), and the narrow bright line which is now all that divides the new and old S. belts.

7. 1885, Feb. 25, $12^h\ 50^m$.—The red spot is but a mere skeleton of its former self. It exists only in outline, and reminds

one forcibly of Gledhill's ellipse. There is a dusky belt, not smooth in tone, immediately S., and several white spots are seen in the usual position on the inner margin of the great S. belt. The bent belt on the N. following side of the spot is still very dark, but the opposite side has faded greatly. All the interior region of the red spot seems involved in a white cloud, which has, however, quite failed to break its continuity of outline. Contemporary with the virtual obliteration of the spot's central area, the line of the ellipse appears much plainer, as if gaining in prominence. The following end is darkest.

8. 1885, May 9, 8^h 8^m.—Red spot has become very much plainer, and the interior light cloud appears nearly dissipated. The following end of the spot is very dark, and shows the black spot noticed in previous years. There is a narrow dark belt distinctly bent down from the spot's S.W. side, and actually connected with it. Some distance further S. there is a very dark broken belt. A white spot is figured N. of the preceding side of the red spot, and the marked decadence of the bent belt on its N. preceding margin, noticed in Feb. 1885, has become more decided. It is now very narrow and faint; it seemingly exists in duplicate on the S. preceding region of the spot. Definition very superb when these details were observed.

As to the present aspect of the red spot, it does not differ essentially from that portrayed in fig. 4 for 1882, Oct. 30. Relatively to its appearance in 1879, '80, and '81, it is faint and shorn of its striking character. But it is much more distinct than in 1883 or 1884; the enclosed light cloud is gone, and the red ellipse of the preceding winter (1884–5) has become diffused into an oval marking similar to that which the spot assumed more than three years ago. I have obtained the following observations during the present apparition:—

Date.	Spot central.	Date.	Spot central.
	h m		h m
1885 Oct. 24	17 32	1885 Dec. 28	16 21
26	19 10	1886 Jan. 2	15 29
Dec. 1	19 0	4	17 6
9	15 40		

These times prove that the rotation period of 9^h 55^m $38^s{\cdot}99$ (=870°·31 Daily rate) adopted by Mr. Marth in his Ephemerides (*Monthly Notices*, vol. xlv. No. 9) corresponds very closely indeed with the present motion and position of the spot. His predicted times based on this rate show an average difference of less than two minutes with the observed times as above. According to my observations here, the spot has exhibited an equable motion since the summer of 1882 (after becoming so much fainter), the mean period being 9^h 55^m $39^s{\cdot}1$. My comparative rotation periods were:—

Dates of Limiting Observations.	No. of Rotations.	Period. h m s
1882 July 29–1883 May 4	674	9 55 39·1
1883 Aug. 23–1884 June 12	710	9 55 39·1
1884 Sept. 21–1885 July 8	700	9 55 39·2

As far as the observations have already progressed during the present opposition, I find the period $9^h\ 55^m\ 40^s{\cdot}3$ from 174 rotations, but the interval of 72 days is too short for good results.

As to the new red spot, so frequently observed during the last opposition and following the old spot $1^h\ 48^m$ ($=65°{\cdot}3$) in the same latitude, I looked for it most carefully before sunrise on January 5, but failed to recover it. It has either disappeared altogether or become extremely faint, like the belt on which it is projected.

Note on the Biela Meteors. By Richard A. Proctor.

At the last meeting of the Society a remark was made to the effect that the radiation of the Biela meteors from an area, instead of a point, might be regarded as affording evidence in favour of a theory propounded by an anonymous writer in the *Times*, who, in an essay on comets and meteors, had maintained that the Biela meteors were probably ejected from the earth. As the author of the article in question, I desire to point out that it has never occurred to me to regard the meteors following Biela's comet as earth-born bodies. I have never heard of any-one who has suggested that they may have been so; nor can I imagine that any astronomer of repute would fail to recognise the overwhelming objections against such a theory. The article referred to definitely mentioned the Biela meteors as probably sprung from Jupiter.

The wide area of the radiant region, by the way, is no new phenomenon. It is interesting as showing how untenable is the belief that a radiant region of small area—not more than two degrees in diameter, for example—can safely be assigned to meteors having the so-called stationary radiants. So soon as the radiant regions of these systems come to be dealt with by several observers, it will be found that they are much larger than has been supposed. All occasion for the assumption of very great velocities will then disappear; nor need the laws of geometry be rejected for the sake of stationary radiant regions, as distinguished from radiant points.

The wide area appears to me to be unquestionably due to changes of direction caused by atmospheric resistance. If this affects meteors falling at the same time in originally parallel streams on the same region of our air, much more must it affect meteors falling in different months.

Barrow-in-Furness:
1886, *January* 6.

Observations of the Meteors of 1885, *November* 27, *made at the Radcliffe Observatory, Oxford.* By W. H. Robinson.

(*Communicated by E. J. Stone, M.A., F.R.S.*)

At $6^h\ 0^m$ P.M. (G.M.T.) great numbers of meteors were observed to be falling, and from comparison with subsequent observations in evening it was inferred that they were thicker about 6.30 than later. But clouds prevailed, more or less, in parts of the sky nearly all the evening.

About $7^h\ 0^m$ the sky was fairly clear, but at

$8^h\ 45^m$ thickly overcast.

At $6^h\ 30^m$, facing South: the meteors appeared to be falling in parallel lines, like the tracks of rain drops. Estimated that they were cutting parallels of Declination at about angles of 45°; but in order to secure greater accuracy reference was made to the stars, and here it was found that the direction was invariably from *α Andromedæ* to *α Pegasi*. Facing North: the meteors were all showering in one direction, as noticed in S., and here it was estimated that the general path formed with the meridian (*sub polo*) an angle of 30°, or more accurately, as ascertained at

$7^h\ 23^m$, from *Polaris* through a point half way between *ε* and *ζ Ursæ Majoris*. They were seldom 1^s in duration, generally $0^s{\cdot}5$ or less, and the usual length of path was between 5° and 10°. The meteors were fairly uniform in brightness, and equal to the brightest stars in *Ursa Major*, or about the second magnitude. Some were equal to *α Lyræ*, and many fainter than third magnitude. Did not notice any as bright as *Venus*, although specially watching for them.

$6^h\ 42^m$. Nearly overcast.

$6^h\ 45^m$. Breaks in N.E. Meteors still falling fast, and often visible through cloud when no stars appeared.

$7^h\ 0^m$. Sky clearing. In the W.S.W. the meteors were falling in the direction *α* to *δ Aquilæ*.

$7^h\ 33^m$. Facing East: appeared to be falling in the Prime Vertical.

$7^h\ 45^m$. Facing West: here also running down the Prime Vertical; clouding.

$8^h\ 15^m$. A clear patch in E. Meteors evidently becoming fewer here.

$8^h\ 30^m$. Clear in places. From south side of Observatory: noticed they were still falling rather fast, average

30 per minute. The brightest leave phosphorescent trains visible for more than 1^{s} after the meteor had disappeared.

8^{h} 38^{m}. Several bright meteors in South about the magnitude of *Capella* and cutting near square of *Pegasus*. Observed in break of clouds.

9^{h} 30^{m}. Partly clear in South. Meteors still falling fairly fast.

The tracks given above when referred to the stars are accurate, but the remainder are only approximate. From the former it is inferred that the radiant-point is situated about

R.A. 1^{h} 30^{m} and N.P.D. 48°,

or very near 50 *Andromedæ*.

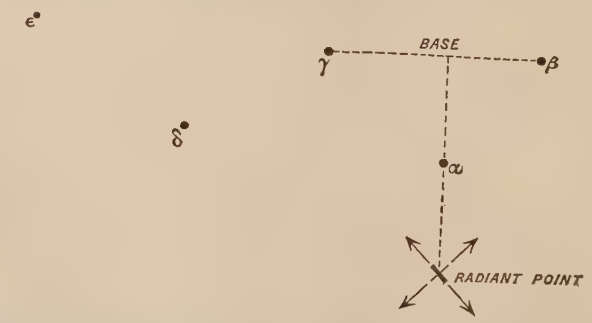
Radcliffe Observatory, Oxford:
1885, *December* 15.

Display of Meteors, 1885, *November* 27. By W. Wickham.

(*Communicated by E. J. Stone, M.A., F.R.S.*)

On the evening of Friday, November 27, I was walking between Islip and Charlton, two villages six to nine miles N.N.E. of Oxford. The night was very dark and cloudy, but at 5.35 P.M. (nearly) I noticed repeated bursts of light behind the clouds.

The sky began to clear in patches, and once, about 6.15 P.M., was almost free from cloud. Having no light with me I could neither record time nor track beyond making the following mental notes:—I remarked that the thickest display occurred about *Cassiopeia*, and it soon became evident that the radiant-point was somewhere S. beyond the five bright stars of *Cassiopeiæ*. Further examination led me to fix the radiant-point at a distance south beyond α *Cassiopeiæ*, equal to a perpendicular let fall from α *Cassiopeiæ* upon a base drawn between β and γ *Cassiopeiæ* (and near ν *Cassiopeiæ*), as shown in the following sketch:—



Most of the time I was facing N.N.E., but turning due south I noticed the general direction of the meteor-paths to be in a

line drawn between *α Andromedæ* and *α Pegasi*. During the clear interval, about 6.15 P.M., I saw thousands of meteors, and counted six falling simultaneously through the N.N.W. The meteors seemed generally of the same magnitude (about 1st star mag.), but I noticed many smaller when the sky was clear for a few minutes. At 6.15 P.M. (about) there were two bright meteors, about the size of *Jupiter*, one on the N.W., the other on the S.W. horizon, both of which exhibited a decided green colour.

All the paths and durations seemed unusually short, the former comprising a luminous track and then a bright burst. With the exception of one hour (from 6.30 to 7.30), I kept watch till 11 P.M., but clouds generally prevailed, although I could see frequent bursts behind them.

Radcliffe Observatory, Oxford:
1885, *December* 15.

The Meteor Shower of 1885, *November* 27. By Major A. C. Bigg Wither.

A grand display of meteors was seen at Quetta, Beluchistan (67° 5′ E., 30° 12′ N.), on November 27, 1885. At 10 P.M., local time, the shower was incessant, and I estimated that over the whole visible hemisphere six or eight meteors in every second were falling at this time. The radiant-point was about half way between the three principal stars in *Aries* and *Cassiopeia*, in *Andromeda*, close to the well-known nebula; and as this part of the heavens was nearly in the zenith at this time, the meteor shower had, so to speak, a most symmetrical appearance. The meteors were mostly not very brilliant—on an average like stars of the 3rd magnitude, moving over arcs of 8° or 10°; but there were some brighter even than stars of the 1st magnitude. Unfortunately circumstances did not permit me to observe for more than a few minutes, and it was only by accident that I saw the shower at all.

Quetta, 1885, *November* 29.

The Meteor Shower of 1885, *November* 27. By Major G. Strahan.

I have been fortunate enough to witness here, on the night of the 27th inst., a most superb display of meteors, and as it is possible they were not visible in England, a short account of them may be of interest to the Society. I first noticed them on leaving my house at about 7.20 P.M., local time, and at that time the shower was most fully established (longitude of Agra is about $5^h\ 10^m$ E.). It was impossible to count them; there were often six or seven visible at once, and there were rarely

intervals of four seconds without one being seen. I should estimate the frequency to be fully fifty per minute or more. The time of maximum must have been about 9.30 P.M., but the full force of the shower really varied very little between the hours of 7.30 and 11.30. A few were still visible at 2 A.M. About 50 per cent. of them might have been equal to 3rd magnitude stars. Meteors equal to 1st magnitude stars were comparatively rare—perhaps not one a minute. A few of the brightest left streaks, slightly reddish, which remained visible some four or five seconds. Some almost stationary meteors were seen near the radiant-point, which I estimated at

R.A. $1^h\ 45^m$. Decl. $+46°$.

I have not had much experience in tracing the paths of meteors, and found it difficult to determine an exact radiant-point; it appeared to me that the tracks of these bodies would not exactly intersect anywhere; but the position given above is the nearest I could arrive at. It is nearly midway between the stars γ *Andromedæ* and 51 *Andromedæ*. I trust that more complete accounts of this phenomenon may reach you from other observers here.

Agra, 1885, *November* 29.

The Meteor Shower of 1885. By Capt. D. Wilson-Barker.

(*Communicated by the Secretaries.*)

On November 27, in lat. 25° 5′ N., long. 60° E. (59° to 61°) we observed a magnificent display of meteors. As soon as the Sun set we could see a regular shower, which reached its maximum between 9.30 P.M. and 10. At that time the third officer and myself, counting in turns, by taking a certain portion of the sky, computed that they were shooting at least 600 per minute. Sir H. Mance, C.S.I., who was on board, thought 1,000 per minute. With a few exceptions they were small meteors. In one exceptional case the track was visible for eight minutes, and for some time longer with the aid of a glass. The radiant-point was situated about the constellation *Triangulum*, a few being observed to shoot from other directions. Towards 3 A.M. the number became plainly less, partly caused perhaps by the Moon. The next evening we saw very few.

S.S. "*Dacia*," *Suez*:
1885, *December* 22.

Observations of the Comet 1885 (*Brooks*), *at Harrow, with the* 18½*-inch Equatorial Reflector.*
By G. L. Tupman.

1886	G.M.T.	Δα (comet − ✶)	Δδ	Comp.	α	L*f p*	δ	L*f p*	
	h m s	m s	′ ″		h m s		° ′ ″		
Sept. 6	9 54 15·2	−1 52·6	−8 35	14	14 3 47·4	+8·719	+38 24 15	+9·847	1
9	9 29 21·1	−0 43·44	−0 12·4	12	14 21 28·46	+8·730	+39 38 43·0	+9·808	2
11	9 28 15·1	+0 21·56	−8 4·5	16	14 33 54·81	+8·736	+40 23 12·6	+9·795	3
13	9 42 43·4	+1 14·27	+3 28·3	13	14 46 53·62	+8·738	+41 3 28·3	+9·806	4
13	9 42 43·4	−0 9·98	−7 7·1	13	14 46 53·62	+8·738	+41 3 26·6	+9·806	5

Mean Places of the Comparison Stars for 1885·0.

	α	s	δ	″	
	h m s		° ′ ″		
1	14 5 39·78	+0·22	+38 32 32·4	+8·0	WB_2, 14h, 77, 78
2	14 22 11·73	+0·17	+39 38 46·2	+9·2	,, 451
3	14 33 33·03	+0·22	+40 31 9·5	+7·6	,, 681, 2
4	14 45 39·20	+0·15	+40 59 48·9	+11·1	,, 960
5	14 47 3·45	+0·15	+41 10 22·4	+11·3	,, 973

Sept. 6. Ring Micrometer. Power 60. Comet has no nucleus: not possible to observe its place with accuracy.

Sept. 9. Ring Micrometer. Comet a little brighter than on Sept. 6.

Sept. 11. Ring Micrometer. Some haze. Observations difficult. The outer and inner rings differ $1^s.5$ and $3''$.

Sept. 13. Crossed Bar Reticule. Power 120. Clear night. Comet 3′ diameter; no nucleus. The R.A.'s of the stars were used to determine the orientation of the reticule.

The comparisons are corrected for refraction and comet's motion.

Biela's Comet.

(*Extract from a letter to Mr. Knobel from Dr. Gill, dated Dec.* 5, 1885.)

"I have been sitting up every night to look for Biela's Comet, near *ζ Centauri* (visible only from 2 to 3.30 A.M.) We have often had fine nights since the 28th till 1 A.M., when the sky has clouded, and I have not yet seen *ζ Centauri*, much less the comet, since the 28th.

"P.S.—Since writing I have searched near *ζ Centauri* and all around in vain for Biela."

Occultation of Aldebaran, 1886, January 16. By Prof. Robert S. Ball, LL.D., F.R.S.

In an interval between two falls of snow, the occultation of *Aldebaran* was observed at this place under favourable circumstances.

I observed with the "South" Equatorial of 12 inches aperture, Mr. Rambaut used the 5-inch Equatorial, while we also had the benefit of the assistance of Mr. J. H. Longford with an excellent 3-inch "Student's Equatorial," by Grubb.

Mr. Longford's time was recorded on the chronograph of the Observatory. Mr. Rambaut took the time from a controlled mean time clock with eye and ear, while I used a chronometer showing sidereal time.

The immersion appeared quite instantaneous in all three instruments.

The definition was very good at the time of both phases.

The times were

	Immersion.	Emersion.
	h m s	h m s
Dr. Ball	7 20 44·4	8 10 31·6
Mr. Rambaut	7 20 43·0	8 10 30 9
Mr. Longford	7 20 44 9	

Dunsink Mean Time.

The Observatory, Dunsink, Co. Dublin:
1886, *Jan.* 17.

Observations of Comets d, 1885 (Fabry), and e, 1885 (Barnard) made at the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

The observations were made with the East or Sheepshanks Equatorial, aperture 6·7 inches, by taking transits over two cross-wires at right angles to each other, and each inclined 45° to the parallel of Declination.

Comet d, 1885.

Greenwich Mean Solar Time. 1885.	Observer.	✱−★ R.A.	Corr. for Par. & Refract. in R.A.	✱−★ N.P.D.	Corr. for Par. & Refract. in N.P.D.	No. of Comp.	Apparent R.A.	Apparent N.P.D.	Comp. Star
d h m s		m s	s	′ ″	″		h m s	° ′ ″	
Dec. 24 7 49 24	H.	+0 25·84	+0·14	− 1 35·4	−3·1	4	23 54 19·26	69 18 56·2	*a*
27 9 27 14	A.D.	−0 4·78	+0·22	−10 42·6	−3·9	3	23 50 3·68	69 17 21 6	*b*
9 36 34		−0 4·94	+0·22	− 0 15·1	−3·5	3	23 50 10·59	69 16 49·0	*c*
9 47 43		−1 3 94	+0·23	−12 44·7	−4·2	3	23 50 0·64	69 17 6·7	*d*

Comet e, 1885.

Dec. 15 11 41 17	H.T.	+0 47 70	+0·08	− 3 28·5	−3·7	5	3 52 29·49	84 5 37·0	*e*
11 44 19		+0 3·46	+0·08	− 5 26·5	−3·8	4	3 52 32·44	84 5 46·8	*f*
27 10 29 50	A.D.	+0 54·39	+0·09	−11 23·8	−4·0	5	3 22 26·36	82 27 33·7	*g*

Mean Places of Comparison Stars.

	Star's Name.	R.A. 1885·0. h m s	N.P.D. 1885·0. ° ′ ″	Authority.
a	W.B. (2) XXIII. 1096	23 53 50·46	69 20 57·2	Weisse's Bessel
b	Lalande 46906	23 50 5 58	69 28 29·6	Lalande
c	Arg. Z. + 20° No. 5397	23 50 12·64	69 17 29·6	Bonn. Obs. vol. vi.
d	Arg. Z. + 20° No. 5401	23 51 1·69	69 30 16·8	„ „ „ iv.
e	Arg. Z. + 5° No. 566	3 51 37 67	84 9 8 6	„ „ „ iii.
f	Arg. Z. + 5° No. 572	3 52 24·86	84 11 16·3	„ „ „ iii.
g	W.B. III. 344	3 21 27·95	82 39 3·0	Schjellerup.

Notes.

Dec. 24 (*d*) Comet very faint; no nucleus.
27 (*d*) Comet faint; circular, with very faint nucleus.
15 (*e*) Small round object; no nucleus or tail.
27 (*e*) Faint, with nucleus.

The observations are corrected for parallax and refraction. The initials H.T., A.D., and H. are those of Mr. Turner, Mr. Downing, and Mr. Hollis respectively.

Royal Observatory, Greenwich:
1886, *January* 8.

Spectroscopic Results for the Motions of Stars in the Line of Sight, obtained at the Royal Observatory, Greenwich, in the year 1885. No. IX.

(*Communicated by the Astronomer Royal.*)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. xxxvi. p. 318, vol. xxxvii. p. 22, vol. xxxviii. p. 493, vol. xli. p. 109, vol. xlii. p. 230, vol. xliii. p. 81, vol. xliv. p. 89, and vol. xlv. p. 330. The observations were made with the "half-prism" spectroscope, one "half-prism" with a dispersion of about $18\frac{1}{2}°$ from A to H being used, except in a few cases of bright stars mentioned in the Remarks, where a train of two "half-prisms," with a dispersion of 80° from A to H, was used. An eyepiece with a magnifying power of 14 was employed throughout.

The cylindrical lens has always been used in front of the slit as in the observations made previously to 1881. A slip of metal coated with Balmain's luminous paint, inserted immediately behind the measuring pointer, has been frequently employed to give a phosphorescent illumination of the field.

The observations of the Moon and of the Sun have been made as a check on the general accuracy of the results.

Motions of Stars in the Line of Sight, in Miles per Second, observed with the Half-prism Spectroscope.

(+ denotes Recession; − Approach.)

The initials M. and N. are those of Mr. Maunder and Mr. Nash respectively.

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				α Andromedæ.			
Nov. 5	M	2	F	+ 8·7	−23·3	−29·5	Definition poor.
17	M	2	F	+11·6	−38·7	−49·8	Spectrum steady; definition good.
28	M	2	F	+13·8	−35·1	−25·7	
Dec. 1	N	2	F	+14·3	−29·8	−30·7	Slit too narrow for satisfactory work.
8	N	2	F	+15·4	−49·3	−47·8	Spectrum bright and steady; star-line distinct.
15	N	2	F	+16·2	−17·2	−16·2	Spectrum bright and steady; star-line faint.
				γ Pegasi.			
Nov. 17	M	2	F	+13·7	−29·6	−38·5	Spectrum tremulous and faint.
Dec. 8	N	2	F	+17·3	−35·9	−35·6	
15	N	2	F	+18·0	−29·2	−30·2	
				α Cassiopeiæ.			
Oct. 5	M	2	b_1	− 5·0	+55·9	+54·4	Spectrum very tremulous; definition bad.
				β Arietis.			
Nov. 17	M	2	F	+ 7·4	−46·5	−49·8	Star-line diffused, and very broad.
Dec. 1	N	2	F	+11·4	−50·1	−57·2	Spectrum faint; measures difficult.
8	N	2	F	+13·2	−31·1	−31·8	
15	N	2	F	+14·7	−30·0	−30·0	Spectrum faint; measures difficult.
				α Arietis.			
Nov. 17	M	2	F	+ 6·3	− 8·9	−14·8	Star-line very faint, and seen with great difficulty.
Dec. 1	N	2	F	+10·4	−35·5	−42·5	Measures difficult.
	N	2	F	+12·2	−38·2	−38·6	
15	N	2	F	+13·9	− 6·6	− 9·4	
				γ Persei.			
Nov. 17	M	2	F	− 0·7	+67·1	+60·8	Spectrum faint; star-line faint and diffused.

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				β Persei.			
Feb. 7	M	2	F	+17·4	−45·1	−57·3	Measures difficult and rough.
Nov. 17	M	2	F	+ 0·4	−39·5	−49·9	Spectrum bright and steady; definition good.
Dec. 8	N	2	F	+ 6·7	−19·7	−20·6	
				α Persei.			
Feb. 7	M	2	F	+16·0	−74·8	−87·2	Spectrum and star-line faint; measures rough.
				Aldebaran.			
Feb. 3	M	2	F	+17·3	+ 7·2	+13·1	Star-line faint, but well defined.
5	M	3	F	+17·6	+ 7·7	+10·3	Definition variable.
7	M	2	F	+17·8	+36·3	+42·0	Star-line faint, and only seen by glimpses.
19	M	2	F	+18·5	+27·4	+16·5	Spectrum and star-line faint.
21	M	2	F	+18·6	+33·5	+26·1	Spectrum and star-line faint, observation rough.
23	M	2	b_1	+18·6	+20·8	+14·0	Spectrum very unsteady.
25	M	2	b_1	+18·6	+18·6	+11·0	Spectrum bright; star-line well seen.
Mar. 10	N	2	b_1	+18·1	+41·4	+39·1	Spectrum unsteady; b lines sharp and distinct.
12	N	1	b_1	+17·9	+14·8	+17·4	Spectrum faint and tremulous; measures rough.
Nov. 5	M	2	F	− 7·7	+31·9	+38·5	Definition fair; measures considered good.
28	M	2	F	− 0·4	+28·7	+19·6	
Dec. 1	N	2	F	+ 0·6	(−20·5)	(−21·2)	Star-line very faint and indistinct.
8	N	2	F	+ 2·9	+26·6	+26·8	Spectrum tremulous; wind high.
15	N	2	F	+ 5·2	+30·9	+27·8	
				Capella.			
Feb. 7	M	4	F	+14·9	+ 2·7	+ 5·0	Spectrum bright and steady.
23	M	2	b_1	+16·7	+19·4	+16·8	Spectrum bright, but *very* unsteady; wind high.
25	M	2	b_1	+16·8	+13·6	+ 7·5	Spectrum very unsteady; star-lines very faint.
Mar. 10	N	2	b_1	+17·2	− 0·1	− 5·0	Star-line very faint.
12	N	3	b_1	+17·1	+31·2	+32·3	Spectrum bright and fairly steady.
Nov. 5	M	2	F	−10·3	+28·6	+31·0	Definition very good; star-line well seen.

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				Rigel.			
Feb. 5	M	2	F	+14·3	+10·6	+ 8·9	Star-line fairly well seen.
7	M	6	F	+14·5	+13·2	+ 8·0	Individual measures discordant.
21	M	2	F	+15·7	+28·5	+21·6	Spectrum very faint; measures rough.
Nov. 5	M	3	F	− 8·3	(−27·2)	(−26·9)	Star-line exceedingly difficult to see. Measures rough.
28	M	2	F	− 2·3	+26·9	+21·5	
Dec. 8	N	2	F	+ 0·5	+23·5	+23·8	Wind very troublesome.
15	N	2	F	+ 2·5	+23·5	+25·0	
				γ Orionis.			
Feb. 5	M	2	F	+15·3	−17·3	−20·0	Spectrum bright and fairly steady.
7	M	4	F	+15·7	−25·9	−31·4	Star-line fairly well seen.
Nov. 5	M	2	F	−10·4	+ 6·9	+ 5·8	Star-line faint; observation difficult.
Dec. 15	N	2	F	+ 1·6	+ 1·9	+ 3·6	
				β Tauri.			
Feb. 5	M	4	F	+15·6	−35·1	−39·6	Star-line diffused and difficult to bisect.
7	M	3	F	+16·0	(−39·8)	(−51·1)	Sky cloudy: measures uncertain.
Nov. 5	M	2	F	−11·2	−26·8	−27·3	Definition fair; measures considered good.
Dec. 8	N	2	F	− 1·2	−37·0	−39·4	
				δ Orionis.			
Feb. 5	M	4	F	+14·4	−23·1	−26·0	Observation very difficult.
				ε Orionis.			
Feb. 5	M	2	F	+14·2	−17·7	−16·6	Spectrum fairly bright and steady.
				ζ Orionis.			
Feb. 5	M	2	F	+13·9	−23·8	−25·5	Star-line fairly well seen by glimpses.
				κ Orionis.			
Feb. 5	M	4	F	+12·6	−24·8	−23·1	Star-line distinctly seen, but difficult to bisect.
				α Orionis.			
Feb. 23	M	2	b_1	+16·7	+21·4	+22·4	Star-line occasionally seen distinctly isolated from the dark band in which it lies.
25	M	2	b_1	+16·9	+12·6	+ 4·5	Spectrum very tremulous

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				β Aurigæ.			
Feb. 7	M	2	F	+13·6	(−49·8)	(−56·3)	Sky cloudy; measures uncertain.
				γ Geminorum.			
Feb. 5	M	4	F	+12·0	−93·7	−79·4	Very large displacement towards the blue; estimations rough.
				Sirius.			
Feb. 3	M	6	F	+ 7·9	−13·4	−15·2	Star-line exceedingly difficult to bisect; slight displacement towards the blue.
5	M	4	F	+ 8·3	−42·5	−47·1	Displacement towards the blue very marked.
7	M	3	F	+ 8·7	(−71·3)	(−50·4)	Sky cloudy; measures uncertain.
Mar. 14	M	4	F	+13·6	−21·4	−23·4	Slight displacement towards the blue.
14	M	4	F	+13·6	−21·9	−25·9	Two-prism train employed.
27	N	2	F	+14·1	−10·3	− 8·9	Measures difficult.
Nov. 5	M	6	F	−12·3	−20·3	−24·9	Spectrum very bright, but tremulous; star-line very broad and ill-defined; star-line suspected not to be symmetrical.
28	M	6	F	− 8·5	− 8·7	− 7·2	*Small* displacement towards the blue.
Dec. 15	N	2	F	− 4·6	−18·4	−16·8	
				Castor.			
Feb. 3	M	2	F	+ 8·4	−21·8	−25·0	Star-line very ill defined.
Mar. 14	M	4	F	+16·7	−38 9	−41·1	Unmistakable displacement towards the blue.
27	N	3	F	+17·8	− 9·9	−11·6	Star-line broad and diffused.
				Procyon.			
Feb. 3	M	2	F	+ 6·6	−12·6	−17·6	Star-line fairly well seen.
5	M	4	F	+ 7·2	− 0·1	− 1·4	Spectrum bright and steady.
Mar. 14	M	4	F	+15·5	−19·5	−20·2	Star-line unusually well defined.
27	N	2	F	+17·0	−33·9	−33·6	Spectrum tremulous.
Dec. 15	N	4	F	− 9·1	−16·8	−15·3	
				Pollux.			
Feb. 3	M	2	F	+ 7·3	−35·2	−34·9	Star-line very faint and difficult to see.
23	M	2	b_1	+12·7	−17·2	−18·3	Star-line exceedingly faint.

Date. 1885.	Obs.	No. of Meas.	Line.	Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
Feb. 25	M	2	b_1	+13·1	−33·4	−40·0	Spectrum very unsteady; star-line fairly dark and distinct.
Mar. 11	M	2	b_1	+15·9	−25·9	−30·2	Spectrum tremulous; star-line fairly well seen.
14	M	4	F	+16·3	−25·6	−24·7	Star-line faint.
Apr. 21	M	2	b_1	+17·8	−23·3	−27·5	Spectrum bright, but very tremulous.
				α Hydræ.			
Feb. 23	M	2	b_1	+ 3·0	+ 8·8	+ 8·2	Star-line seen with the greatest difficulty; measures very rough.
Mar. 11	M	2	b_1	+ 7·5	+ 5·5	+ 6·8	Spectrum faint and tremulous; definition fair.
				Regulus.			
Mar. 14	M	2	F	+ 8·3	−15·7	−20·2	Star-line fairly well defined.
Apr. 18	M	2	F	+15·9	+ 6·9	+ 3·0	Definition exceedingly bad.
				γ' Leonis.			
Mar. 11	M	2	b_1	+ 7·4	+23·0	+23·2	Star-line faint, but seen well by glimpses.
				α Ursæ Majoris.			
Aug. 14	M	1	F	− 1·7	− 3·4	− 5·7	Spectrum faint; definition poor.
				β Leonis.			
Mar. 14	M	4	F	+ 1·4	−16·5	−14·4	Star-line dark, very broad and ill defined at edges; displacement evidently small.
				δ Ursæ Majoris.			
Aug. 10	M	2	F	+ 2·1	+30·1	+29·4	Star-line broad and ill defined; observations very difficult.
				ε Ursæ Majoris.			
Aug. 10	M	4	F	+ 3·4	−41·7	−41·1	Definition fair; observation difficult.
				ε Virginis.			
Mar. 11	M	2	b_1	− 5·1	+ 7·6	+ 6·8	Star-line very difficult to see.
Apr. 29	M	2	b_1	+ 9·1	−18·0	−22·5	Star-line faint and difficult to see.
				Spica.			
Mar. 14	M	2	F	− 8·6	−25·5	−28·1	Star-line faint and very badly defined; measures very rough.
				ζ Ursæ Majoris.			
Aug. 10	M	2	F	+ 4·2	+34·6	+32·9	Both stars observed as one; definition fair.

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				η Ursæ Majoris.			
Aug. 10	M	4	F	+ 6·2	+14·6	+15·7	Small displacement towards the red.
				α Draconis.			
Aug. 10	M	4	F	+ 2·1	+34·9	+35·0	Star-line broad and diffused at edges.
				Arcturus.			
Mar. 11	M	2	b_1	− 8·2	−12·5	−13·5	Spectrum bright, but tremulous; star-line faint.
14	M	2	F	− 7·5	−46·7	−52·8	Star-line faint; definition poor.
Apr. 29	M	2	b_1	+ 4·6	−35·8	−40·2	Spectrum exceedingly tremulous; definition bad.
May 7	N	2	b_1	+ 6·6	−70·3	−74·1	Spectrum faint; cloudy.
29	N	3	b_1	+11·1	−48·3	−50·9	Star-line faint; measures difficult.
June 2	N	2	F	+11·8	−36·7	−35·2	Star-line very faint.
2	N	2	F	+11·8	−42·0	−43·5	Definition much improved.
18	N	2	F	+13·9	−47·5	−46·0	Measures considered good.
July 9	M	2	F	+15·2	−52·1	−43·1	Spectrum tremulous; definition bad.
				α Coronæ Borealis.			
July 9	M	2	F	+11·7	+ 4·9	− 0·5	Spectrum faint; definition bad.
Aug. 17	M	2	F	+12·4	−11·8	−12·4	Star-line very broad, but the edges of the line are sharper than in many stars of the type; measures discordant.
				ζ Draconis.			
Aug. 10	M	2	F	+ 1·1	−46·1	−44·4	Spectrum faint, but steady.
				α Ophiuchi.			
June 18	N	2	F	+ 1·8	−38·4	−37·9	Displacement towards the blue appeared certain.
July 9	M	2	F	+ 6·6	−39·9	−34·6	Spectrum faint; definition poor.
23	N	2	F	+ 9·4	−30·5	−32·2	Star-line faint; measures doubtful.
				Vega.			
May 29	N	2	F	− 4·8	(− 7·4)	(− 6·8)	Measures doubtful.
July 9	M	2	F	+ 0·6	−32·1	−28·5	Spectrum bright but tremulous.
Aug. 3	M	2	F	+ 4·0	−33·9	−34·9	Definition variable.
5	M	2	F	+ 4·2	−42·9	−41·3	Spectrum faint; definition fair.
10	M	2	F	+ 4·8	−54·6	−53·0	Star-line very broad and diffused.

Date 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
Aug. 17	M	2	F	+ 5·6	−26·9	−27·2	Definition good.
25	M	2	F	+ 6·5	−35·5	−37·5	Definition fair.
27	M	2	F	+ 6·6	−19·5	−21·1	Spectrum tremulous.
29	M	2	F	+ 6·8	−38·1	−37·8	Spectrum bright and steady.
Nov. 5	M	4	F	+ 7·7	−34·2	−37 8	Cloudy; definition poor; observation difficult.
17	M	2	F	+ 6·6	−38·8	−53·2	Spectrum bright, but very unsteady.
18	N	2	F	+ 6·5	−44·3	−43·4	
					ζ Aquilæ.		
Nov. 17	M	4	F	+12·0	−25·0	−23·7	Spectrum very faint and tremulous; measures very difficult.
					Altair.		
July 9	M	2	F	− 3·3	−45·0	−38·6	Spectrum fairly steady.
23	N	2	F	+ 0 3	− 4·7	− 4·9	Star-line broad.
Aug. 3	M	2	F	+ 3·2	−50 6	−40·3	Spectrum faint; observation difficult; large displacement towards the blue.
25	M	2	F	+ 8·5	−50·1	−49·8	Definition fair.
29	M	2	F	+ 9·4	−36·0	−38·3	Cloudy; spectrum steady.
Nov. 17	M	2	F	+14·8	−73·6	−64·3	Spectrum very tremulous.
18	N	2	F	+14·7	−35·5	−35·3	Star-line diffused; measures difficult and doubtful.
					γ Cygni.		
Nov. 17	M	2	F	+10 2	−11·7	−12·0	Spectrum fairly steady; definition good.
					α Cygni.		
July 9	M	2	F	− 6·4	−35·4	−29·0	Spectrum steady; definition good.
Aug. 25	M	2	F	− 0·1	−30·5	−33·0	Spectrum steady; definition fair.
Sept. 26	M	2	b_1	+ 4·6	−67·7	−68·2	Spectrum very tremulous; definition bad.
Nov. 17	M	2	F	+ 9·3	−40·9	−40·4	Spectrum steady; definition good.
18	N	2	F	+ 9·4	−40·6	−40·2	
					ε Cygni.		
Nov. 17	M	5	F	+12·2	+ 7·1	+ 2·3	Spectrum steady; star-line faint.
					α Cephei.		
Aug. 25	M	2	F	− 4·0	−17·3	−20·8	Spectrum faint, but steady; measures difficult.
Nov. 17	M	2	F	+ 4·7	−33·0	−40·1	Spectrum steady; definition fair.

Date. 1885.	Obs.	No. of Line. Meas.		Earth's Motion in M. per sec.	Concluded Motion of Star. Meas.	Estimd.	Remarks.
				β Pegasi.			
Oct. 5	M	2	b_4	+ 4·1	−31·9	−30·6	Spectrum bright, but tremulous; the b_1 lines could not be isolated from the shaded band in which they lie.
				α Pegasi.			
July 23	N	2	F	−13·0	−18·5	−20·4	Spectrum faint; star-line indistinct; measures doubtful.
Aug. 25	M	2	F	− 5·5	+ 8·8	+ 7·3	Spectrum faint, but steady; definition fair.
Nov. 17	M	2	F	+15·9	−23·7	−28·6	Definition fair.
Dec. 15	N	2	F	+17·9	− 3·6	− 5·7	Star-line broad and dark.

Moon.

Date.	Obs.	No. of Meas.	Line.	Motion Measured.	Remarks.
Feb. 3	M	5	F	− 3·1	
19	M	5	F	−11·6	Measures discordant.
21	M	5	F	−10·3	Coincidence appeared perfect; measures discordant
23	M	5	b_1	− 2·1	Coincidence appeared perfect.
25	M	5	b_1	− 3·5	Coincidence appeared perfect.
Mar. 27	N	4	F	− 1·1	
Apr. 21	M	5	b_1	− 1·6	
29	M	5	b_1	− 1·6	Coincidence appeared perfect.
May 29	N	4	b_1	− 2·0	Coincidence appeared perfect.
July 23	N	4	F	+ 2·6	Coincidence appeared perfect.
Aug. 25	M	5	F	− 4·1	Coincidence appeared perfect.
Nov. 17	M	5	F	− 2·8	Coincidence appeared perfect.
18	N	4	F	− 1·5	Coincidence appeared perfect.
Dec. 15	N	4	F	+ 1·4	Coincidence appeared perfect.

Sun.

Nov. 6	M	5	F	− 0·4	

Venus.

Oct. 16	M	15	b_1	−14·0	−7·8	Computed Motion −7·4.

Rotation of Jupiter.

Displacement between the *p* and *f* limbs.

				p−*f*.	
Apr. 21	M	5	b_1	+31·6	Position Circle Reading 207° 30′; slit tangential to the planet's limb, the outer edge of the slit being placed exactly on the limb; cylindrical lens before the slit.

Date.	Obs.	No. of Meas.	Line.	Motion Measured.	Remarks.
Apr. 21	M	5	b_1	+20·4	Position Circle Reading 117° 30′; slit radial; no cylindrical lens.
27	M	2	b_1	+28·8	Position Circle Reading 207° 30′; slit tangential, the outer edge of the slit being placed exactly on the limb; cylindrical lens before the slit.
29	M	3	b_1	+17·2	
29	M	3	b_1	+30·7	Position Circle Reading 27° 30′; slit tangential; cylindrical lens before the slit.

Displacement between the *n* and *s* limbs.

				$n-s$.	
Apr. 29	M	3	b_1	− 0·4	Position Circle Reading 117° 30′.
29	M	3	b_1	− 2·0	Position Circle Reading 297° 30′; slit tangential at both positions, the outer edge of the slit being placed exactly on the limb; cylindrical lens before slit.

Computed relative motion of the *p* and *f* limbs 30·9 miles per second, the equatorial diameter of *Jupiter* being taken as 88,000 miles, and its period of rotation as $9^h\ 56^m$.

Rotation of Saturn's Rings.

Displacement between the *p* and *f* ansæ.

				$p-f$.	
Apr. 21	M	10	b_1	+26·7	Position Circle Reading 180° 0′; the inner edge of the slit was placed on the Cassinian division. Lines very faint and difficult to see. It was not found possible to observe the relative displacement of lines from the *p* and *f* limbs of the planet.

Computed Relative motion of the ansæ 19·4 miles per second, the diameter of the outer ring being taken as 170,000 miles, and the point observed being assumed to be 1″·5 from the extremity of the major axis of the ring.

Observations of Occultations of Stars and Uranus by the Moon, and of Phenomena of Jupiter's Satellites, made at the Royal Observatory, Greenwich, in the year 1885.

(*Communicated by the Astronomer Royal.*)

Occultations of Stars and Uranus by the Moon.

Day of Obs.	Phenomenon.		Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation.	Observer.
						h m s	
1885, Feb. 20 (*a*)	Disapp.	38 Arietis	Simms' Eq.	220	Dark	7 40 37·53	H. T.
20	,,	38 Arietis	Altaz	100	,,	7 40 37·57	A. D.
20 (*a*)	,,	38 Arietis	E. Eq.	70	,,	7 40 37·59	H.
23 (*a*)	,,	130 Tauri	Altaz	100	,,	11 2 21·94	H. T.
23	,,	130 Tauri	E. Eq.	140	,,	11 2 21·54	T.
Mar. 22	,,	W. B. (2) V. 445	Simms' Eq.	220	,,	6 48 38·77	H. T.
22	,,	111 Tauri	,,	,,	,,	6 51 33·07	,,
22	,,	111 Tauri	Altaz	100	,,	6 51 32·54	T.
22	,,	111 Tauri	E. Eq.	210	,,	6 51 32·44	H.
22	,,	117 Tauri	Lassell Refl.	250	,,	9 2 33·95	W. C.
22	,,	117 Tauri	Simms' Eq.	220	,,	9 2 34·37	H. T.
22	,,	117 Tauri	Altaz	100	,,	9 2 34·01	T.
27 (*b*)	,,	B. F. 1464	Lassell Refl.	250	,,	10 23 28·61	H. T.
27 (*c*)	,,	B. F. 1464	Simms' Eq.	220	,,	10 23 28·15	C.
27	,,	43 Leonis	Altaz	100	,,	11 36 26·08	H. T.
27	,,	43 Leonis	Simms' Eq.	220	,,	11 36 25·72	C.
27	,,	43 Leonis	E. Eq.	210	,,	11 36 25·98	A. D.

Day of Obs.		Phenomenon.		Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
1885. Mar.	28 (*d*)	Disapp.	B. F. 1589	E. Eq.	210	Dark	10 18 40·00	T.
	28	,,	75 Leonis	Simms' Eq.	220	,,	12 13 38·84	H. T.
	28	,,	75 Leonis	E. Eq.	210	,,	12 13 38·14	T.
	28	,,	75 Leonis	Altaz	100	,,	12 13 38·54	L.
	31 (*e*)	Reapp.	B. F. 1886	,,	,,	Bright	10 27 50·47	W. C.
Apr.	20 (*f*)	Disapp.	Anonyma	Simms' Eq.	220	Dark	10 26 2·72	H. T.
	20	,,	λ Geminorum	,,	,,	,,	10 58 57·73	,,
	20	,,	λ Geminorum	Altaz	100	,,	10 58 57·44	T.
	20	,,	λ Geminorum	E. Eq.	210	,,	10 58 57·62	L.
	20 (*g*)	Reapp.	λ Geminorum	Simms' Eq.	220	Bright	11 20 18·73	H. T.
	20 (*h*)	,,	λ Geminorum	Altaz	100	,,	11 20 25·32	T.
	20 (*i*)	,,	λ Geminorum	E. Eq.	210	,,	11 20 22 82	L.
July	20 (*j*)	Disapp.	o^2 Libræ	Altaz	100	Dark	10 57 0·92	H.
	22	,,	29 Ophiuchi	,,	,,	,,	10 31 57·29	A. D.
	22	,,	29 Ophiuchi	E. Eq.	210	,,	10 31 56·99	H.
Aug.	20	,,	Piazzi XVIII. 82	,,	,,	,,	11 38 47·25	,,
Sep.	1	Reapp.	θ^2 Tauri	,,	,,	,,	10 51 57·27	H. T.
	1 (*k*)	,,	θ^2 Tauri	Altaz	100	,,	10 51 57·41	S. D.
	1	,,	Bradley 619	E. Eq.	70	,,	11 32 17·14	H. T.
	1 (*k*)	,,	Bradley 619	Altaz	100	,,	11 32 17·01	S. D.
	1	,,	85 Tauri	E. Eq.	70	,,	12 0 33·25	H. T.

Day of Obs.	Phenomenon.		Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation. h m s	Observer.
1885, Sep. 19 (*k*)	Disapp.	13 Capricorni	E. Eq.	210	Dark	8 4 9·90	A. D.
20	,,	18 Aquarii	,,	,,	,,	6 48 32·71	H. T.
21	,,	Bradley 2930	Simms' Eq.	220	,,	10 7 44·97	A. D.
25 (*l*)	,,	μ Piscium	E. Eq.	,,	Bright	8 11 25·50	L.
Oct. 1 (*k*)	,,	λ Geminorum	Altaz	100	,,	12 38 14·33	A. P.
1 (*k*)	,,	λ Geminorum	E. Eq.	210	,,	12 38 16·22	R. W.
Nov. 17	,,	Piazzi XXIII. 270	,,	,,	Dark	10 40 37·17	L.
30	,,	Uranus 1 L	,,	70	Bright	16 59 34·75	,,
30 (*m*)	,,	Uranus 2 L	,,	,,	,,	16 59 35 55	,,
30	Reapp.	Uranus 1 L	,,	,,	Dark	18 9 26·17	,,
30 (*n*)	,,	Uranus 2 L	,,	,,	,,	18 9 27 07	,,
Dec. 28 (*l*)	Disapp.	θ Virginis	Altaz	100	Bright	16 5 38·55	J. P.
28 (*o*)	Reapp.	θ Virginis	Lassell Refl.	350	Dark	17 14 50 76	H. T.
28	,,	θ Virginis	Altaz	100	,,	17 14 46·40	J. P.

Notes.

(*a*) Disappearance instantaneous.
(*b*) Star much fainter than expected.
(*c*) Observation doubtful owing to difficulty in keeping the faint star steadily in view; telescope shaken by wind.
(*d*) Star very faint; Moon very bright.
(*e*) Observation doubtful, star's light overpowered by that of the Moon.
(*f*) Angle from vertex about 70°; star 6th or 7th magnitude.
(*g*) Reappearance instantaneous.
(*h*) Probably late.
(*i*) Observation good.
(*j*) Star very faint; observation considered unsatisfactory.
(*k*) Cloudy.
(*l*) Limb very unsteady.
(*m*) The planet seemed to take about 1 sec. to disappear.
(*n*) Dark limb of Moon very distinct.
(*o*) Probably too late; the star reappeared very near the edge of the field.

Phenomena of Jupiter's Satellites.

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
						h m s	h m s	
1885, Jan. 4 (*a*)	III.	Occ. D.	First contact	E. Eq.	140	11 22 36	11 25	L.
			Last seen	,,	,,	11 28 11		
	III.	Occ. R.	Bisection	,,	,,	14 59 36	15 0	H. T.
8	IV.	Tr. Ing.	First contact	Simms' Eq.	220	14 1 1		,,
(*b*)			Bisection	,,	,,	14 4 46		,,
			Last contact	,,	,,	14 6 41		,,
			First contact	E. Eq.	140	14 1 20	14 12	L.
			Bisection	,,	,,	14 4 19		,,
			Last contact	,,	,,	14 6 49		,,
(*c*)	IV.	Tr. Egr.	Last contact	Simms' Eq.	220	18 50 42	18 43	H. T.
20	II.	Occ. R.	Bisection	,,	,,	11 14 8		,,
			Last contact	,,	,,	11 15 53		,,
(*d*)			First seen.	E. Eq.	210	11 13 35	11 15	T.
			Last contact	,,	,,	11 14 50		,,
25	IV.	Tr. Egr.	First contact	,,	,,	9 28 55		A. D.
			Last contact	,,	,,	9 37 24	9 40	,,
			Last contact	Simms' Eq.	220	9 37 56		L.
27	II.	Occ. R.	First seen	E. Eq.	140	13 30 37	13 33	,,
			Last contact	,,	,,	13 34 51		

M

Day of Obs.	Satellite.	Phenomenon.	Telescope.	Powe	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
					m s	h m s	
1885, Jan. 29 (*e*)	III.	Tr. Ing. First contact	E. Eq.	210	11 16 34	11 19	A.D.
Feb. 2 (*f*)	I.	Tr. Ing. Bisection	,,	140	12 13 49	12 12	J. P.
		Last contact	,,	,,	12 15 34		
3	I.	Occ. R. Last contact	,,	210	11 42 12	11 41	H. T.
(*g*)	II.	Ec. D. Last seen	,,	,,	13 8 12	12 9 27	,,
5	II.	Tr. Egr. First contact	,,	,,	9 59 34		
		Bisection	,,	,,	10 2 48	10 8	B.
		Last contact	,,	,,	10 5 48		
9 (*h*)	III.	Occ. R. First seen	Simms' Eq.	220	7 50 57		W. C.
		Bisection	,,	,,	7 52 27		,,
		Last contact	,,	,,	7 55 57		,,
(*i*)		First seen	Altaz	100	7 51 43		H. T.
		Last contact	,,	,,	7 58 31	7 53	,,
(*j*)		First seen	S.E. Eq.	220	7 50 3		M.
		Bisection	,,	,,	7 54 8		,,
		Last contact	,,	,,	7 59 7		,,
(*k*)		Last contact	E. Eq.	210	7 54 22		T.
11 (*l*)	I.	Tr. Egr. First contact	,,	,,	10 37 1		H. T.
		Bisection	,,	,,	10 39 40	10 41	
		Last contact	,,	,,	10 42 50		

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, Feb. 18	I.	Tr. Ing.	Last contact	Simms' Eq.	220	10 9 48		„
			First contact	E. Eq.	210	10 3 47		L.
			Bisection	„	„	10 5 57	10 6	„
			Last contact	„	„	10 8 16		„
	I.	Tr. Egr.	First contact	„	„	12 21 20		
			Bisection	„	„	12 23 44	12 25	„
			Last contact	„	„	12 25 49		
19 (*d*)	IV.	Ecl. R.	First seen	Lassell Refl.	145	8 44 42		W. C.
			First seen	Simms' Eq.	220	8 45 3		H. T.
(*m*)			First seen	S.E. Eq.	310	8 44 13		M.
			Bisection	„	„	8 49 23		„
			Full brightness	„	„	8 53 43	8 41 52	„
(*d*)			First seen	E. Eq.	210	8 46 2		T.
(*n*)			First seen	Altaz	100	8 45 10		L.
			Full brightness	„	„	8 49 9		„
23 (*o*)	III.	Occ. D.	First contact	„	„	10 43 10		H. T.
			Bisection	„	„	10 47 59		„
			Last seen	„	„	10 52 14		„
(*o*)			First contact	E. Eq.	70	10 43 24	10 49	T.
			Last seen	„	140	10 54 7		„
			First contact	Simms' Eq.	220	10 44 24		L.
			Last seen	„		10 52 54		„

Day of Obs.	Satellite.	Phenomenon.	Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, Feb. 23 (*o*)	III.	Ecl. R. First seen	E. Eq.	140	14 51 58	14 49 46	T.
25	I.	Tr. Ing. First contact	Lassell Refl.	170	11 47 36		H. T.
		Last contact	,,	,,	11 51 51		,,
		First contact	E. Eq.	140	11 47 51	11 50	L.
		Bisection	,,	,,	11 50 6		,,
		Last contact	,,	,,	11 52 35		,,
	I.	Tr. Egr. First contact	,,	,,	14 6 13	14 9	,,
		Last contact	,,	,,	14 11 42		
	I.	Sh. Egr. First contact	,,	,,	14 15 12	14 19	,,
		Last contact	,,	,,	14 18 26		
Mar. 2 (*p*)	III.	Occ. D. First contact	,,	210	14 3 31	14 6	H. T.
		Bisection	,,	,,	14 8 40		
		Last seen	,,	,,	14 11 30		
4	I.	Tr. Ing. First contact	,,	,,	13 32 5	13 34	H.
		Last contact	,,	,,	13 34 28		
	I.	Tr. Egr. First contact	,,	,,	15 49 6	15 54	L.
		Last contact	,,	,,	15 54 20		
	I.	Sh. Egr. First contact	,,	,,	16 8 18	16 14	,,
		Last contact	,,	,,	16 11 18		

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, Mar. 7 (*e*)	I.	Ecl. R.	First seen	Simms' Eq.	220	7 49 31		L.
			Full brightness	,,	,,	7 52 23		,,
(*e*)			First seen	E. Eq.	210	7 51 21	7 49 4	A. P.
			Full brightness	,,	,,	7 54 21		,,
14	I.	Ecl. R.	First seen	,,	,,	9 43 28	9 43 20	A. D.
			Full brightness	,,	,,	9 45 35		
(*q*)	II.	Occ. D.	First contact	,,	,,	13 17 30	13 21	,,
			Last seen	,,	,,	13 21 59		
16	II.	Tr. Egr.	First contact	T. C.	200	10 23 57	10 24	S. D.
20 (*r*)	III.	Tr. Ing.	First contact	E. Eq.	210	10 20 25		T.
			Bisection	,,	,,	10 24 40		,,
			Last contact	,,	,,	10 29 54		,,
(*r*)			First contact	Simms' Eq,	220	10 19 16	10 24	H.
			Bisection	,,	,,	10 23 40		,,
			Last contact	,,	,,	10 28 26		,,
	I.	Tr. Ing.	First contact	E. Eq.	210	11 28 39		
			Bisection	,,	,,	11 31 29	11 31	T.
			Last contact	,,	,,	11 34 13		
(*o*)	I.	Tr. Egr.	First contact	Simms' Eq.	220	13 47 26	13 51	H. T.
			Last contact	,,	,,	13 51 46		

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, Mar. 20 (*s*)	III.	Tr. Egr.	First seen	Simms' Eq.	220	13 55 31		
			Bisection	,,	,,	13 57 1	14 2	,,
			Last contact	,,	,,	14 0 46		
23	II.	Tr. Ing.	First contact	E. Eq.	210	9 45 0		A. D.
			Last contact	,,	,,	9 51 14		,,
			First contact	Simms' Eq.	220	9 47 12	9 46	L.
			Last contact	,,	,,	9 50 37		,,
27	I.	Tr. Ing.	First contact	,,	,,	13 16 17		H.T.
			Bisection	,,	,,	13 18 12		,,
			Last contact	,,	,,	13 21 27		,,
			First contact	E. Eq.	210	13 14 29	13 18	A.D.
			Bisection	,,	,,	13 17 59		,,
			Last contact	,,	,,	13 20 58		,,
(*o*)	III.	Tr. Ing.	First contact	Simms' Eq.	220	13 46 27		H. T.
			Bisection	,,	,,	13 50 12		,,
			Last contact	,,	,,	13 55 42		,,
(*t*)			First contact	E. Eq.	210	13 47 9	13 50	A. D
			Bisection	,,	,,	13 49 53		,,
			Last contact	,,	,,	13 54 23		,,
28	I.	Occ. D.	First contact	,,	,,	10 25 1		
			Bisection	,,	,,	10 26 31	10 25	T.
			Last seen	,,	,,	10 27 46		

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, Mar. 30	I.	Ecl. R.	First seen	E. Eq.	210	8 1 5	8 0 54	H.
			Full brightness	,,	,,	8 2 59		
(*u*)	II.	Tr. Ing.	First contact	,,	,,	12 4 54	12 6	,,
			Last contact	,,	,,	12 8 59		
31 (*p*)	III.	Ecl. R.	First seen	Lassell Refl.	250	10 42 13	10 41 50	W. C.
			Full brightness	,,	,,	10 48 58		,,
			First seen	E. Eq.	210	10 42 49		A. D.
			Full brightness	,,	,,	10 47 12		,,
Apr. 14	I.	Tr. Egr.	First contact	Simms' Eq.	220	8 5 10	8 9	H. T.
			Bisection	,,	,,	8 7 55		
			Last contact	,,	,,	8 9 10		
(*r*)	III.	Occ. D.	First contact	Altaz	100	10 37 30	10 43	,,
(*r*)			First contact	Simms' Eq.	220	10 39 18		L.
17 (*o*)	II.	Tr. Egr.	Last contact	E. Eq.	210	9 2 48	9 2	H.
18 (*v*)	IV.	Tr. Egr.	First contact	,,	,,	11 31 52	11 36	T.
			Bisection	,,	,,	11 37 51		
			Last contact	,,	,,	11 42 50		
20	I.	Occ. D.	First contact	Simms' Eq.	220	10 17 48	10 19	H. T.
			Bisection	,,	,,	10 19 13		,,
			Last seen	,,	,,	10 21 31		,,
			First contact	E. Eq.	210	10 16 57		L.
			Last seen			10 21 22		,,

Day of Obs.	Satellite.	Phenomenon.		Telescope.	ower.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
						h m s	h m s	
1885, Apr. 21	I.	Tr. Egr.	First contact	E. Eq.	210	9 55 59	9 59	H.
27	IV.	Ecl. R.	First seen	Lassell Refl.	250	8 35 5		A. D.
			Full brightness	,,	,,	8 41 43	8 35 43	,,
			First seen	E. Eq.	210	8 35 59		T.
29	I.	Ecl. R.	First seen	,,	,,	10 8 51	10 8 58	A. D.
			Full brightness	,,	,,	10 10 46		
May 1	II.	Tr. Ing.	First contact	,,	,,	11 3 35		
			Bisection	,,	,,	11 7 14	11 5	T.
			Last contact	,,	,,	11 10 59		
9 (*w*)	III.	Tr. Ing.	First contact	,,	,,	11 51 59		
			Bisection	,,	,,	11 57 38	11 56	J. P.
			Last contact	,,	,,	12 2 8		
13	IV.	Occ. D.	Bisection	,,	,,	9 55 46		A. D.
			Last contact	,,	,,	9 59 15		,,
(*x*)			Last contact	S.E. Eq.	310	9 57 44	9 58	M.
			First contact	Simms' Eq.	220	9 51 54		H.
			Bisection	,,	,,	9 54 32		,,
			Last seen	,,	,,	9 58 22		,,

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation.	Mean Solar Time of N.A.	Observer.
						h m s	h m s	
1885, May 13	I.	Occ. D.	First contact	E. Eq.	210	10 21 41		A. D.
			Bisection	,,	,,	10 24 11		,,
			Last seen	,,	,,	10 26 56		,,
			First contact	S.E. Eq.	310	10 22 29		M.
			Bisection	,,	,,	10 25 14	10 25	,,
			Last seen	,,	,,	10 27 39		,,
			First contact	Simms' Eq.	220	10 24 13		H.
			Bisection	,,	,,	10 25 57		,,
			Last seen	,,	,,	10 27 34		,,
	III.	Ecl. R.	First seen	E. Eq.	210	10 36 51		A. D.
			Full brightness	,,	,,	10 41 8		,,
(1)			First seen	S.E. Eq.	310	10 36 24		M.
			Bisection	,,	,,	10 38 9	10 35 42	,,
			Full brightness	,,	,,	10 39 44		,,
			First seen	Simms' Eq.	220	10 36 53		H.
			Full brightness	,,	,,	10 39 46		,,
May 20	III.	Ecl. D.	Last seen	E. Eq.	210	11 13 10	11 10 36	T.
22	I.	Ecl. R.	First seen	,,	,,	10 22 53	10 22 55	A. D.
			Full brightness	,,	,,	10 24 17		

Day of Obs.	Satellite.	Phenomenon.		Telescope.	Power.	Mean Solar Time of Observation. h m s	Mean Solar Time of N.A. h m s	Observer.
1885, May 27 (*e*)	III.	Occ. D.	First contact	E. Eq.	210	9 54 15		
			Bisection	,,	,,	9 56 11	9 57	H.
			Last seen	,,	,,	9 58 1		
June 2 (*y*)	II.	Tr. Ing.	First contact	Simms' Eq.	220	10 48 46		H. T.
			Bisection	,,	,,	10 50 1		,,
			Last contact	,,	,,	10 53 36	10 50	,,
(*u*)			Last contact	Lassell Refl.	75	10 51 19		H.
13	I.	Tr. Ing.	First contact	Altaz	100	9 55 0		A. D.
			Last contact	,,	,,	10 0 9	10 0	,,
(*k*)			Last contact	E. Eq.	210	9 59 37		T.
Nov. 16 (*z*)	II.	Tr. Ing.	First contact	Lassell Refl.	350	16 30 53	16 35	H. T
			Last contact	,,	,,	16 35 8		
Dec. 28 (*u*)	III.	Ecl. D.	Began to fade	,,	,,	14 31 9		
			Bisection	,,	,,	14 34 54	14 31 54	,,
			Last seen	,,	,,	14 36 24		
(*z*)	I.	Tr. Ing.	First contact	,,	,,	17 26 16		
			Bisection	,,	,,	17 28 21	17 31	,,
			Last contact	,,	,,	17 32 56		
	III.	Ecl. R.	First seen	,,	,,	17 32 41	17 31 49	,,
			Full brightness	,,	,,	17 42 31		

Notes.

(*a*) Very faint; cloudy.

(*b*) Bisection considered a little late.

(*c*) Observation doubtful; frost on lenses made satellite almost invisible.

(*d*) Hazy.

(*e*) Cloudy; observation uncertain.

(*f*) Satellite distinctly visible on *Jupiter*'s disc $6^m\ 15^s$ after last contact.

(*g*) Not a very good observation. Hazy; cloud in the neighbourhood.

(*h*) Definition bad; limb boiling; observation very rough. The satellite appeared to be quite clear of the planet 1^m after time of last contact.

(*i*) Definition bad; satellite clear of the planet at $8^h\ 2^m$.

(*j*) Images very unsteady; definition bad. Limb of *Jupiter* very tremulous. The first phase was the best observed; the other times are rough.

(*k*) Very diffused.

(*l*) Definition fair. Satellite quite clear of the planet at $10^h\ 44^m$.

(*m*) The satellite reappeared much closer to the planet than had been expected. The phenomenon was scarcely distinguishable from an occultation. The satellite was, therefore, not noticed until it had obtained some degree of brilliancy. A faint projection of the limb of the planet (as in an occultation) had been seen some little time previously, but no notice had been taken of it, as the satellite was expected to reappear some appreciable distance from the planet. The first glimpse of it would probably be about 45^s to 50^s earlier than the first time recorded. The second and third times are worth very little.

(*n*) Probably late, as the satellite was so very faint and near planet.

(*o*) Definition not good.

(*p*) Definition fair.

(*q*) Very tremulous.

(*r*) Cloudy.

(*s*) Definition bad; cloudy.

(*t*) First contact a little uncertain.

(*u*) Observation not considered satisfactory. Limb of planet ill-defined.

(*v*) Hazy. Planet ill-defined.

(*w*) Observation difficult. *Jupiter* very tremulous and ill-defined.

(*x*) The observer was unable to use the driving clock, and in consequence of difficulty in keeping the telescope on the planet, he missed first part of observation. Satellite IV. was distinctly seen after last contact; so also Satellite I., but less distinctly. The appearance in both cases was exactly similar to that seen in a transit, just as the satellite is wholly within the limb. The observer was not quite sure that the whole of Satellite IV. was seen, but by far the greater part was visible. That part of the limb of the satellite nearest the centre of the planet was faint and indistinct, and could not quite be traced; of Satellite I. less could be seen than of Satellite IV.

(*y*) Definition bad, planet low down.

(*z*) Definition bad.

Phenomena of the Satellites of Jupiter and Saturn, and Occultations of Stars by the Moon, observed at Mr. Edward Crossley's Observatory, Bermerside, Halifax, in the year 1885, *with the* $9\frac{1}{3}$*-inch Cooke Refractor.*

By Joseph Gledhill, F.R.A.S.

Phenomena of Jupiter's Satellites.

(Power 240.)

Date.	Satellite.	Phenomena.	G.M.T. h m s	N.A. h m s	Remarks.
1885, Feb. 2	IV.	Ec. D. Fading?	10 1 0	10 8 28	Poor definition.
		Fading	10 3 0		
		Half gone	10 6 30		
		Last seen	10 10 30		
	I.	Sh. I. Just within	11 50 0	11 48 0	
	I.	Tr. I. First contact	12 11 30	12 12 0	
		Bisection	12 13 30		
		Inner contact	12 15 30		
3	I.	Ec. D. Fading?	9 0 0	9 1 54	Misty.
		Fading	9 1 0		
		Just gone	9 2 30		
	I.	Oc. R. Bisection	11 40 0	11 4 1	E. C. at telescope.
	II.	Ec. D. Last seen	12 9 55	12 9 27	
4	I.	Sh. E. On disc	8 42 0	8 37 0	Bad sky.
	I.	Tr. E. Just off	8 59 0	8 57 0	
5	II.	Sh. E. Just off	9 30 0	9 28 0	

Date.	Satellite.	Phenomena.	G.M.T. h m s	N.A. h m s	Remarks.
	II.	Tr. E. Outer contact	10 10 0	10 8 0	
1885, Feb. 9	III.	Oc. R. „ „	7 56 0	7 53 0	
17	I.	Ec. D. Last seen	12 50 5	12 49 16	Some cloud.
	II.	Ec. D. „ „	17 23 10	17 22 29	Some cloud.
18	I.	Sh. I. Just within	10 7 0	10 5 0	Shadow not seen.
	I.	Tr. I. „ „	10 7 0	10 6 0	
	I.	Tr. E. Just off	12 27 0	12 25 0	Bad sky.
19	IV.	Ec. R. First seen	8 41 30	8 41 52	
	I.	Oc. R. Outer contact	9 35 0	9 34 0	
	II.	Tr. I. „ „	11 39 0	11 38 0	
		Just within	11 41 0		
20	I.	Tr. E. Inner contact	6 49 0	6 51 0	
		Outer contact	6 52 0		
25	I.	Tr. I. On disc	11 57 0	11 50 0	Too late at telescope.
	I.	Tr. E. Outer contact	14 10 0	14 9	Cloudy.
27	I.	Tr. E. Inner contact	8 31 0	8 35	E. C. at telescope.
		Bisection	8 32 30		
		Outer contact	8 34 0		
	I.	Sh. E. Inner contact	8 45 0	8 48	
		Bisection	8 46 0		
	IV.	Tr. I. First contact	9 33 0	9 38 0	The satellite was nearly as dark as a shadow after $10^h\ 30^m$.
		Second contact	9 38 0		

Date.	Satellite.	Phenomena.	G.M.T. h m s	N.A. h m s	Remarks.
1885, Feb. 27	IV.	Sh. I. Just within	11 31 0	11 34 0	
28	II.	Oc. D. First contact	8 45 0	8 48 0	Fair sky.
		Half gone	8 48 0		
		Just gone	8 50 0		
	II.	Ec. R. First seen	12 9 56	12 10 5	
		Half disc?	12 13 0		
		Full?	12 15 0		
Mar. 6	III.	Tr. E. First contact	7 13 0	7 19 0	Fair definition.
		Half off	7 15 0		
		Outer contact	7 17 0		
	I.	Tr. I. First contact	8 0 0	8 0 0	Bad sky now.
		Bisection	8 2 0		
		Inner contact	8 4 0		
	I.	Sh. I. Bisection	8 22 0		
		Just within	8 25 0	8 23 0	
	III.	Sh. E. Inner contact	8 42 0	8 50 0	
		Half off	8 46 0		
		Just off?	8 48 0		
	I.	Tr. E. Bisection	10 17 0	10 20 0	Good definition.
		Last contact	10 20 0		
	I.	Sh. E. First contact	10 41 0	10 42 0	Clouds pass and hide planet.

Phenomena of Saturn's Satellites.

(Power 240.)

January 6, 1885.—Good definition.

Enceladus, S.; very difficult; not up at 8^h, $8^h\ 5^m$, $8^h\ 10^m$, $8^h\ 15^m$, $8^h\ 17^m$, $8^h\ 20^m$ up? $8^h\ 25^m$ past? $8^h\ 30^m$ past.

Tethys, N.; definition poor; not up at $16^h\ 15^m$; up between $16^h\ 16^m$ and $16^h\ 17^m$ probably; $16^h\ 23^m$ past.

January 7.—Very good definition when the clouds clear away; high wind.

Dione, N.; $10^h\ 50^m$, $10^h\ 55^m$ not up; $10^h\ 58^m$ not quite up; $11^h\ 0^m$ on line? $11^h\ 5^m$, on line; $11^h\ 10^m$ past.

January 8.—Very good definition.

Enceladus, N.; reached the telescope too late to see the approach; on the line at $9^h\ 50^m$? $9^h\ 52^m$? $10^h\ 0^m$ past? $10^h\ 2^m$ past.

Tethys, N.; not up at $13^h\ 20^m$, $13^h\ 25^m$; up at $13^h\ 27^m$? $13^h\ 29^m$? $13^h\ 30^m$? past at $13^h\ 33^m$? $13^h\ 35^m$ past.

January 10.—Stormy; bright and clear occasionally

Tethys, N.; $10^h\ 45^m$ not up; $10^h\ 47^m$ up? $10^h\ 49^m$, $10^h\ 50^m$ up? $10^h\ 55^m$ past.

Enceladus, S.; very difficult object; on line at $11^h\ 0^m$? clouds now obscured the planet.

January 11—Windy; snow showers; often clear for a short time.

Tethys, S.; not up at $9^h\ 0^m$, $9^h\ 10^m$, $9^h\ 15^m$, $9^h\ 20^m$, $9^h\ 23^m$, $9^h\ 24^m$, $9^h\ 25^m$ up? $9^h\ 30^m$ $9^h\ 32^m$ up? $9^h\ 35^m$ past? $9^h\ 40^m$ past.

January 12.—Clear at intervals.

Dione, E.; $6^h\ 45^m$, $6^h\ 48^m$ not up? $6^h\ 49^m$, $6^h\ 50^m$ up? $6^h\ 52^m$ up? Clouds now came over.

Tethys, N.; difficult; $8^h\ 0^m$, not yet quite up. Cloud then hid the planet.

January 13.—Bad sky.

Tethys, S.; judged on line between $6^h\ 40^m$ and $6^h\ 50^m$; cloud and snow put an end to observation.

January 14.—Bad sky; could not see *Dione* steadily.

Dione, S.; $7^h\ 0^m$ not up; $7^h\ 5^m$ to $7^h\ 7^m$ up? $7^h\ 9^m$ $7^h\ 10^m$ up? $7^h\ 15^m$ up? $7^h\ 17^m$ past? $7^h\ 20^m$ past.

February 2.—Stormy; good light.

Dione, S.; $10^h\ 45^m$ to $10^h\ 47^m$ not up; $10^h\ 49^m$ to $10^h\ 53^m$ up? $10^h\ 55^m$ certainly not short of line; $10^h\ 57^m$ past? $10^h\ 58^m$ past.

February 3.—Misty; sat. very faint.

Tethys, E.; $12^h\ 15^m$ not up; $12^h\ 30^m$ past.

February 5.—Windy; wet; bright sky occasionally.

Rhea, N.; reached the Observatory too late for the approach; $9^h\ 50^m$ to $9^h\ 52^m$ up? $9^h\ 54^m$ to $9^h\ 55^m$ up; $9^h\ 57^m$ past? $9^h\ 59^m$ past.

Tethys, E.; $9^h\ 45^m$ to $9^h\ 47^m$ on web? $9^h\ 50^m$ past? $9^h\ 52^m$ past.

Enceladus, S.; glimpsed now and then; on web between $11^h\ 45^m$ and $11^h\ 50^m$.

February 7.—Stormy; often very clear.

Enceladus, E.; a very faint point of light suspected on or very near line at $6^h\ 5^m$.

Tethys, E.; $6^h\ 45^m$ to $6^h\ 50^m$ not up; $6^h\ 50^m$ to $6^h\ 57^m$ very nearly on line or quite so; $6^h\ 57^m$ to $7^h\ 0^m$ judged on line; probably past at $7^h\ 5^m$; certainly past at $7^h\ 10^m$.

February 9.—*Dione*, N.; $7^h\ 0^m$ not up; $7^h\ 2^m$ nearly up, $7^h\ 5^m$ on line? $7^h\ 8^m$ on line? $7^h\ 10^m$ past.

February 20.—*Tethys*, E.; $11^h\ 50^m$ not quite up; $12^h\ 0^m$ up? $12^h\ 5^m$ up? $12^h\ 10^m$ past.

Titan is now nearly at E. elongation.

February 22.—*Enceladus*, E.; suspected on line at 8 P.M.

Dione also.

Rhea, $8^h\ 40^m$ $8^h\ 42^m$ not up; $8^h\ 45^m$ $8^h\ 50^m$ up? $9^h\ 0^m$ past? $9^h\ 5^m$ past.

Tethys, just up at $9^h\ 12^m$; not up at $9^h\ 15^m$? $9^h\ 17^m$ to $9^h\ 25^m$ up? $9^h\ 30^m$ past.

February 25.—*Enceladus*, N.; on line at $8^h\ 45^m \pm$.

February 28.—*Dione*, N.; glimpsed occasionally; not on web at $10^h\ 45^m$; on between $10^h\ 50^m$, and $11^h\ 0^m$; past, at $11^h\ 5^m$.

March 7.—Good definition; *Dione*, S.; on web between $7^h\ 0^m$ and $7^h\ 10^m$; $7^h\ 15^m$ past.

March 9.—*Enceladus*, E.; extremely faint; $9^h\ 20^m$ up? $9^h\ 30^m$ past? $9^h\ 35^m$ certainly past. The sky clouded before *Tethys* reached the line.

March 11.—*Tethys*, E.; $8^h\ 50^m$ nearly up; $9^h\ 0^m$ up? $9^h\ 5^m$ past? $9^h\ 10^m$ past.

Dione, N.; $9^h\ 35^m$ nearly on line; $9^h\ 40^m$ and $9^h\ 45^m$ up? $9^h\ 50^m$ past? $10^h\ 0^m$ past.

March 12.—*Rhea*, E., easy; a little past at $10^h\ 20^m$.

Enceladus, N., very difficult; judged on line between $10^h\ 20^m$ and $10^h\ 30^m$.

March 13.—*Tethys*, E., cloudy often; on line about $6^h\ 40^m$.

Dione, E., between $11^h\ 40^m$ and $11^h\ 50^m$; planet low in W.; misty.

March 21.—*Tethys*, N. On the line $7^h\ 15^m$ to $7^h\ 20^m$? $7^h\ 25^m$ past.

Enceladus, S., faint; clearly seen, $8^h\ 10^m$ $8^h\ 15^m$ not up; $8^h\ 20^m$ $8^h\ 25^m$ up? $8^h\ 30^m$ past.

Rhea, E., badly seen; on line $11^h\ 30^m$ $11^h\ 34^m$.

December 15.—Good definition.

Tethys, S.; $9^h\ 42^m$ $9^h\ 47^m$ not up; $9^h\ 50^m$ nearly or quite up; $9^h\ 55^m$ still on line? $10^h\ 0^m$ past.

Lunar Occultations.

January 21, 1885.—B.A.C. 57; fair definition; power, 62; aperture, $9\frac{1}{3}$ inches.
Disappearance, $5^h\ 38^m\ 5^s$, G.M.T.
Reappearance, $6^h\ 48^m\ 33^s$ „
Nautical Almanac times, $5^h\ 39^m$ and $6^h\ 52^m$.

February 20.—38 *Arietis*, $0^h\ 5^m$, escaped occultation; never very near the Moon's limb.

February 22.—α *Tauri*; disappearance, $5^h\ 9^m \pm$; reappearance, $5^h\ 55^m\ 13^s$, G.M.T.

A New Form of Governor for the Driving-Clocks of Equatorials.
By A. Hilger.

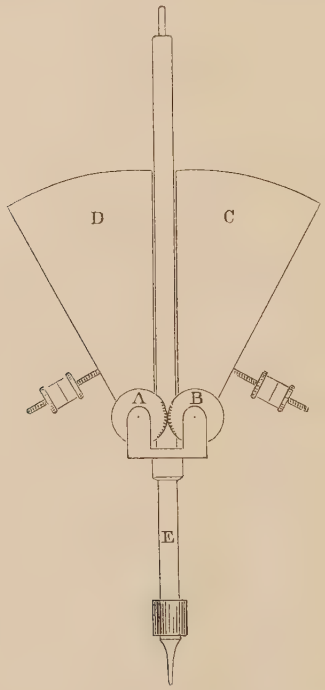
I have the honour of bringing before the Royal Astronomical Society a driving governor which I believe will prove of interest to those who consider uniformity of motion an important matter for an equatorial telescope, and especially to those engaged in the photography of the heavenly bodies.

In former years I have made a great number of Foucault's clocks, with the construction of which many Fellows will be well acquainted, and which twenty years ago were considered—as perhaps they are still, especially in France—the best form of driving-clock for an equatorial. My governor, so far as the fans are concerned, much resembles that of Foucault. A somewhat similar governor, but with three fans, was devised by the late M. Yvon Villarceau; besides these I do not know of any other fan governors, though such may undoubtedly exist.

But there were points in the Foucault governor with which I was by no means satisfied, especially the great complication of pieces and the great amount of friction, which all means error. I do not believe in any form of control which depends upon friction, and finding that, generally speaking, all driving-clocks are so controlled, I have worked out the present design, which is the result of years of experience. I do not think that any governor could have less friction while in action than this particular form, which I claim as my own invention. The friction is entirely confined to the four fine points which carry the two fans D and C. There is no other friction in the governing action whilst these are in motion.

In all forms of governors the clock is liable to go slower either when the fans or governor-balls close, or when the driving weight is reduced. It is not so with this form of clock; an addition of 140 lbs. more or less to the driving-weight will make no appreciable difference in the speed. The speed remains unchanged whether the fans are wide open or nearly closed; I say nearly closed, because, of course, as soon as the fans touch the spindle the control ceases.

The fans are pulled towards the spindle E by chronometer springs in box A and B, which will only allow them to open when a speed of from twenty-five to thirty revolutions a second is attained. The spring is only wound up half a revolution, so that the mean motion of the fans, which does not exceed more than thirty degrees on either side, keeps the spring perfectly free in the air. There is also another very important point in this governor: you will observe that there is no parallelogram motion to keep the fans equally inclined to the centre spindle, and yet that under every variation of position, from vertical to horizontal, the fans always open symmetrically.



When I first tried the governor I found that the rate varied appreciably with the inclination of the fans to the spindle. To overcome this defect I attached small weights to the fans on screws perpendicular to their long axes: and by adjusting the position of these weights on the screws, I found it possible to obtain a quite uniform rate for a very considerable variation in the driving weight, or—what would be the same thing in actual practice—in the friction of the instrument driven.

Note on Mr. Marth's "Intersects." By H. H. Turner, B.A., B.Sc

§ 1. In some recent numbers of the *Monthly Notices* (vol. xlv. pp. 370 and 483), Mr. Marth has described an interesting method of obtaining a graphical representation of the Solar System, each orbit being represented by its trace on a plane which passes through the centre of the Sun and revolves about an axis perpendicular to the ecliptic. The following brief remarks on the general nature of these curves may be of interest:—

§ 2. Let

S be the centre of the Sun, and P any point in the orbit.

i = inclination of orbit to the ecliptic.

ω = angle between line of nodes and major axis of orbit.

r = distance of P from S.

w = „ „ „ „ line of nodes.

x = „ „ „ „ directrix of orbit.

z = „ „ „ „ major axis of orbit.

y = „ „ „ „ ecliptic.

p = „ „ S „ directrix of orbit.

Then we have the following relations among these quantities:—

$$\left.\begin{aligned} y &= w \sin i \\ r &= ex \\ r^2 &= (x-p)^2 + z^2 \\ w &= z\cos\omega - (x-p)\sin\omega \end{aligned}\right\} \quad \ldots\ldots\ldots \quad (1)$$

Eliminating w, x, z from these four equations, we get the equation

$$e^2 r^2 \cos^2\omega = e^2 y^2 \operatorname{cosec}^2 i + 2ey(r-ep)\sin\omega \operatorname{cosec} i + (r-ep)^2 \quad \ldots \quad (2)$$

and considering the point in the intersect corresponding to P, as defined by the coordinates r and y, this is the equation to the "intersect."

§ 3. If we write x in place of r in this equation (where x is now the usual Cartesian coordinate), we get the conic

$$x^2(1-e^2\cos^2\omega) + 2e\sin\omega\operatorname{cosec} i \,.\, xy + e^2 y^2 \operatorname{cosec}^2 i,$$
$$-2e^2 p \sin\omega \operatorname{cosec} i \,.\, y - 2ep\,x + e^2 p^2 = 0.$$

The second invariant is

$$e^2 \sin^2\omega \operatorname{cosec}^2 i\,(e^2-1)$$

so that the conic is an ellipse, parabola, or hyperbola, as e is $<$, $=$, or $>$ 1 ; *i.e.* is of the same kind as the orbit.

§ 4. The "intersect" may be laid down graphically from this conic in the following manner:—Draw a series of lines parallel to the axis of x, and cutting the axis of y ; and with radius equal to the distance on one of these lines between the axis of y and the curve, and the origin as centre, cut this line by a small circular arc. The points of intersection will trace out the "intersect."

The reverse operation will reproduce the conic from the intersect. I have shown in a diagram (Plate 4) some of these conics traced from Mr. Marth's intersects in *Monthly Notices*, vol. xlv. plate 3. Corresponding points in two curves are at the same distance from the axis of x; and one set of curves may be regarded as a kind of distortion of the other.

It is readily seen that

(a) The intersect as given by the equation is symmetrical to the axis of y, since r contains x^2 only. In actual fact, however, we limit the plane to one side of the axis of y.

(b) At points on the axis of x the conic and intersect touch each other, and are generally similar in the neighbourhood of this axis.

(c) Points on the lines $y = \pm x$ for the conic correspond to points on the axis of y for the intersect, and the intersect corresponding to portions of the conic in the quadrants made by these lines remote from the axis of x is imaginary.

In the particular case under consideration, the points of intersection of the conic with the lines $y = \pm x$ are given by the equation

$$[x(e \sin \omega \operatorname{cosec} i + 1) - ep]^2 + e^2 x^2 \cos^2 \omega \cot^2 i = o. \quad . \quad . \quad . \quad (3)$$

which gives imaginary values of x, unless either $\cot i = o$, in which case the orbit is perpendicular to the ecliptic, and the intersect coincides with it, the conic becoming (part of) a straight line parallel to the axis of y ; or $\cos \omega = o$, in which case the intersect is part of a conic, and the conic again becomes part of a straight line. The equations of course represent the whole of this conic and this straight line respectively, but we must adduce further considerations to determine which parts of the curves actually correspond to the orbit.

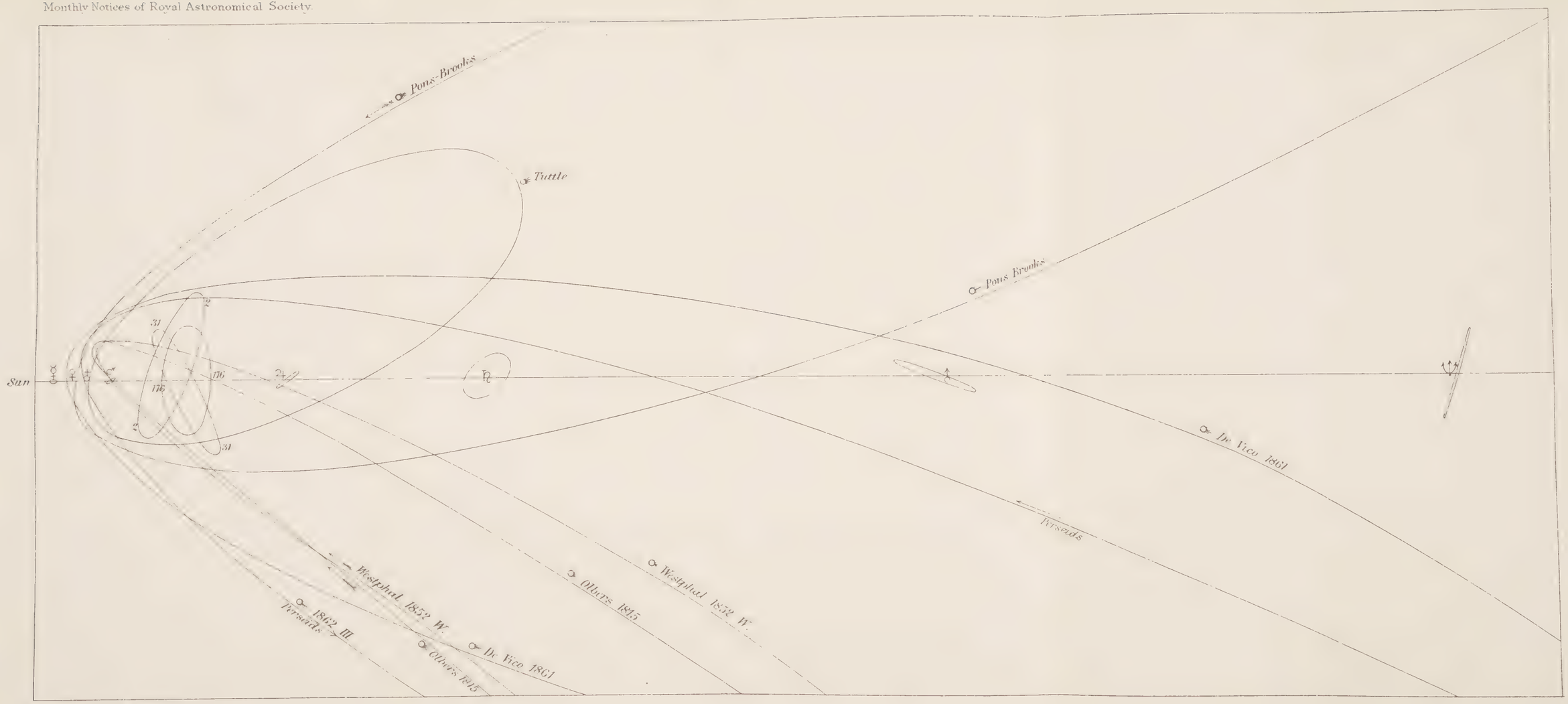
(d) If the conic breaks up into two straight lines, the "intersect" breaks up into two conics with axis of y as major axis and origin as focus. In fact, the equation to the intersect is then of the form

$$(ar + by + c)(a'r + b'y + c') = o,$$

and

$$r = -\frac{by}{a} - \frac{c}{a}$$

evidently represents such a conic.


Pons-Brooks
Tuttle
Pons-Brooks
Sun
31
2
176
176
24
31
De Vico 1861
Perseids
Westphal 1852 W.
Olbers 1815
Westphal 1852 W.
Olbers 1815
1862 III
Perseids
De Vico 1861

§ 5. As regards the representation of the Solar system, there are several points in which a diagram of these conics would give much the same information as the diagram of intersects; and, for the construction of such a diagram, in place of the series of co-ordinates for different points tabulated so carefully by Mr. Marth, it would only be necessary to specify the coordinates of the centre, inclination and magnitude of the axes of the conic, to enable any one to reproduce the curves with an ellipsograph. Ambiguity as regards the position of the *major* axis might be removed by giving also the coordinates of the points where the conic cuts the axis of x.

The following expressions for these quantities are readily deducible. If a be the major axis of the orbit, putting

$$e = \sin\phi,\ \sin i \cos\omega = \cot\psi$$

coordinates of centre of conic are

$$x = a \qquad y = -a \sin\phi \sin i \sin\omega :$$

the inclination of the axis to the axis of x is θ, where

$$\tan 2\theta = \frac{\sin\phi \tan\omega \sin 2\psi}{\cos^2\psi \sec^2\omega - \sin^2\phi}$$

The axes are α and β, where

$$\frac{1}{\alpha} \pm \frac{1}{\beta} = \frac{2\sqrt{\cos^2\psi \tan^2\omega + \cos^2(\phi \mp \psi)}}{a \cos\psi \sin 2\phi}$$

§ 6. When the eccentricity of the orbit, and therefore of the corresponding conic, is nearly unity, as in the case of a comet, it may be advisable, owing to the centre occurring outside the limits of the paper employed for plotting the curves, to treat the conic as a parabola, and in this case the position of the focus and directrix will be more useful. The expressions for the co-ordinates of the focus when e is unity are

$$\alpha = \frac{q(1 + \operatorname{cosec}^2 i)}{2(\sin^2\omega + \operatorname{cosec}^2 i)} \text{ and } \beta = \alpha \cdot \frac{\sin\omega}{\sin i}$$

and the equation to the directrix is

$$x + y \sin\omega \sin i = \frac{q}{2} \cos^2 i$$

where q is the semi-latus-rectum of the orbit. The conic can then be drawn by any of the mechanical methods for describing a parabola with given focus and directrix.

§ 7. A diagram of these conics would exhibit facts about perihelion distances perhaps more readily than that of the actual intersects: it need only be remembered that proximity to the Sun is here translated into proximity to the axis of y; and the perihelion and aphelion distances are thus distances from the axis of y to tangents parallel to it.

Facts about "inclination," on the other hand, are not exhibited so obviously. In the neighbourhood of the axis of x the inclination of the radius vector to the axis of x for the conic is nearly equal to that of the corresponding radius in the orbit to the plane of the ecliptic. But a radius in the orbit perpendicular to the ecliptic is represented in the case of the conic by a radius at an angle of 45° with the axis of x; and between these two extremes the inclination suffers a distortion or reduction increasing in value from zero to one half.

Still all comparative properties of two orbits are represented in very much the same way; *e.g.* the agreement or divergence of two orbits of the same comet, computed from different elements, would be exhibited equally well by the diagram of conics; and, since Mr. Marth seems to regard this possibility of recognising at a glance the agreement or divergence of two orbits as one of the chief uses of his diagrams, perhaps the greater facility in tabulation might recommend this rather more artificial but similarly useful method of diagrammatic representation in some cases.

§ 8. I have made a diagram (Plate 4) of the conics corresponding to some of Mr. Marth's intersects, given in the *Monthly Notices*, vol. xlv. Plate 3, by the actual process described in § 4, so that the scale is in a sense the same as in his diagram. The curves for the major planets, being in the neighbourhood of the axis of x, are almost precisely the same on either system.

In the following table are given the calculated values of the coordinates of centre, inclination of axis, and lengths of axes of the conics corresponding to the major planets and a few of the minor planets. I find that these elements may be computed for each planet in less than half an hour:—

Planet.	Coordinates of Centre.		Inclination of Major Axis.	Lengths of Axes.	
			° ′		
Mercury	0·387	−0·005	159 29	0·083	0·038
Venus	0·723	−0·000	5 25	0·042	0·003
Earth	1·000	+0·000	0 0	—	0·000
Mars	1·524	+0·004	18 51	0·009	0·006
Jupiter	5·203	+0·005	25 14	0·292	0·005
Saturn	9·555	+0·009	28 6	0·578	0·358
Uranus	19·218	−0·012	163 49	0·921	0·032
Neptune	30·111	+0·008	74 42	0·988	0·013
(2)	2·763	+0·294	70 20	1·634	0·393
(31)	3·145	−0·276	115 7	1·533	0·302
(84)	2·363	−0·019	166 5	0·566	0·359
(153)	3·951	−0·079	142 18	0·832	0·229
(176)	3·192	−0·001	89 47	1·207	0·525
(190)	3·947	+0·065	32 31	0·762	0·112

Note on the Transit of the Planet Mars and its Satellites across the Sun's disc, which will occur for the Planet Jupiter and its Satellites on April 13, 1886. By A. Marth.

In a "Note on the Transit of the Earth and Moon across the Sun's disc as seen from *Mars* on Nov. 12, 1879," published in vol. xxxix., the statement may be found (on page 487) that the last transit of *Mars* for *Jupiter* had occurred on Aug. 13, 1785, and that the next one would take place, I presumed, in April 1886. Considering the rarity of the event, I have thought it worth the trouble to compute the circumstances of the case properly, in order to gain some distinct notions of the details of the occurrence. But as the data and explanations necessary for verification and more detailed computations would require more space than this note is intended to occupy, I content myself with merely communicating some of the deduced results.

The transit will begin on April 12 at $20^h\ 35^m$ Greenwich Mean Time with the ingress of *Deimos* upon the Sun's disc for the preceding edge of *Jupiter's third* satellite, and will end on April 13 at $18^h\ 17^m$ Greenwich Mean Time, with the egress of *Deimos* for the following edge of the *second* satellite; so that the whole transit will last for *Jupiter's* system 21 hours 42 minutes, during which interval *Phobos* will have made two full revolutions and three-quarters, and *Deimos* nearly three-quarters of a revolution. For *Jupiter* itself the transit will begin on April 13 at $0^h\ 27^m$ with the ingress of *Deimos* at sunset for a point in 16° of jovicentric northern latitude, and in 108° or 175° western longitude, according as the longitudes are reckoned from the Zero-Meridian in the first or second system of longitudes adopted in the ephemeris published in vol. 45, p. 504 ff. The transit will end at $16^h\ 2^m$ with the egress of *Deimos* at sunrise for a point in 14° of jovicentric northern latitude and in 138° or 200° of longitude, so that for *Jupiter* the whole transit of *Mars* and its satellites will last 15 hours 35 minutes, during which interval *Jupiter* itself will have performed one full rotation and a half. With the exception of the small region within 2° of the north pole, the whole surface of *Jupiter* will have come into sunlight, while *Mars* and its satellites are before the disc; for a region extending approximately from longitude 294° to 312° in the first system of longitudes, or from 356° to 19° in the second system, or for a region including the neighbourhood of the great spot, the ingress of *Mars* and of both satellites will take place in the evening of one Jovian day, the middle passage in the middle of the next day, and the egress in the morning of the third Jovian day.

The Greenwich mean times of ingress and egress for the four satellites of *Jupiter* and for the points of first and last touch of the planet with the contact-cones are given below. The angles of position are those of the centre of *Mars*, as seen from *Jupiter*,

and as reckoned from the point which is in the direction of the north pole of *Jupiter's* equator. The jovicentric apparent diameter of the Sun is $352''\cdot57$, that of *Mars* $2''\cdot46$; the greatest elongation of *Phobos* from the centre of *Mars* is $3''\cdot40$; that of *Deimos* $8''\cdot50$. At $8^h\ 14^m$ the centres of *Mars* and of the Sun will be jovicentrically at their least apparent distance $40''\cdot30$.

Ingress of	*Deimos.*	*Phobos.*	*Mars.* Ext. C.	*Mars.* Int. C.	Angle of Position.
	h m	h m	h m	h m	°
for Sat. III. April 12	20 36	20 56	20 46	20 52	74·6
Sat. IV.	21 38	21 58	21 54	22 1	75·1
Sat. II. April 13	0 3	0 20	0 26	0 34	75·8
♃ prec. l.	0 27	0 39	0 45	0 51	79·6
Sat. I.	still eclipsed		1 8	1 16	76·5
♃ foll. l.	1 6	1 22	1 24	1 30	78·4

Egress of	*Phobos.*	*Mars.* Int. C.	*Mars.* Ext. C.	*Deimos.*	
for Sat. III. April 13	10 34	10 25	10 32	10 43	285·3
Sat. IV.	14 0	14 1	14 9	14 29	285·9
♃ prec. l.	14 53	14 58	15 5	15 22	286·1
♃ foll. l.	15 33	15 38	15 44	16 2	284·9
Sat. I.	16 43	16 42	16 48	17 1	283·3
Sat. II.	18 6	17 56	18 3	18 17	284·1

The following statements may probably interest some readers.

During the sixty years from 1830 to 1890 there will have taken place seventeen transits of *Mercury* over the Sun's disc for *Jupiter* and its satellites, against seven as seen from the Earth. The dates and the heliocentric longitudes are :—

1833 Dec.	1·8	34·1	°	1863 Aug.	22·7	°	212·5
1834 Mar.	1·2	42·3		— Nov.	21·0		219·4
1840 Jan.	15·9		215·6	1869 July	25·5	36·4	
1845 Sept.	19·9	32·2		— Oct.	22·9	44·5	
— Dec.	18·3	40·3		1875 Sept.	8·9		217·8
1851 Nov.	3·8		214·0	1881 May	13·7	34·5	
1852 Feb.	2·0		220·9	— Aug.	11·0	42·7	
1857 July	9·0	30·3		1887 Aug.	27·8		216·1
— Oct.	6·4	38·4					

Venus has during these sixty years crossed the Sun's disc for *Jupiter* eight times :—

1834 Dec.	7·5	67·4	°	1858 Apr.	16·7	55·7	°
1840 Oct.	2·9		235·7	1864 Oct.	5·3		244·1
1846 Aug.	12·1	61·6		1876 June	10·3		239·0
1853 Jan.	30·3		249·2	1882 Apr.	19·7	65·2	

As regards the Earth, the oppositions of *Jupiter* to the Sun or the inferior conjunctions of the Earth recur at intervals of eighty-three years in approximately the same ecliptical longitudes. Nearly one-half of this period of eighty-three years is barren of transits, while during the other half there occur usually eight transits. A cycle of transits ended with that which occurred 1765, Jan. 5·0, in hel. longit. 105°·5. After an interval of forty years without transits the Earth and Moon crossed the Sun's disc for *Jupiter* on the following dates :—

1806 June	25·2	in hel. long.	273°·4	1811 Dec.	23·3	in hel. long.	91°·2
1818	30·1		278·1	1823	28·0		96·1
1830 July	5·0		282·9	1836 Jan.	1·7		100·9
1842	10·0		287·8	1848	6.1		105·1

or at intervals of alternately five and six synodical revolutions. After a barren interval of forty years, a similar cycle of transits will begin with that of 1889 June 24·3 in long. 273°·4, and end with the transit of 1931 Jan. 6. In the course of time changes occur in this arrangement. The transit next preceding that of 1765 Jan. 5 occurred, not in 1759, but 1752 Dec. 31·3, in hel. long. 100°·7 or near the same node, the conjunction of 1759 July 9·6 in long. 287°·6 being merely a close conjunction, the Earth and Moon passing for *Jupiter* just outside the Sun's disc.

So much about the transits of the inferior planets which occur for *Jupiter* and its satellites. Now a few remarks about the occasions when *Jupiter* itself crosses the Sun's disc for the three outer planets.

Since 1690, when *Uranus* was first observed, there have already occurred two transits of *Jupiter* for *Uranus*—at midsummer 1706, and 1789 May 10 in hel. long. 124°·2. The next two transits, I presume, will take place near the other node in the years 1914 and 1997.

As regards *Neptune*, it would demand stricter computations than I have made, and would probably require improved tables, to state decisively whether the conjunctions of the years 1613 and 1779 in the past and those of the years 2022 and 2188 in the future are such close conjunctions as to produce actual transits of *Jupiter* for *Neptune*.

However, the chief question is that concerning transits of *Jupiter*, which may occur for *Saturn*, and, what for observers on the Earth is of greater interest, geocentric occultations of *Saturn* by *Jupiter*. The closest conjunction at which the two planets have been seen since the invention of the telescope was the geocentric conjunction of February 8, 1683, in long. 136° ·7, when the two planets in their retrograde courses passed one another at a distance of 11′. The conjunction was the middle one of a triple conjunction, such as had not occurred since 1425, and as will not occur again till 1940, as I mentioned in an oral communication

made at one of the meetings of the Royal Astronomical Society in 1877 (see the *Astronomical Register*, vol. 15, p. 159). A closer conjunction, both heliocentrically and geocentrically, than that of 1683, was that of July 1623, which was, however, invisible, as it took place not long before the conjunctions of the two planets with the Sun. After twenty-two heliocentric conjunctions since 1623, the next minimum conjunction will occur in May 2080, in which year the two planets will come into opposition to the Sun early in August. The following minima will occur in May 2477, January 2875, &c. An examination of the question, made with the help of Le Verrier's tables in 1878, has satisfied me, that during the next two thousand years as well as during the last two thousand years, or during a full period of four thousand years, no conjunction of the two planets can be found, which takes place so near to the line of nodes of their orbits as to produce a transit of *Jupiter* across the Sun's disc for *Saturn*, or an occultation of *Saturn* by *Jupiter* for observers on Earth.

Ephemeris of the Satellites of Mars, 1886. By A. Marth.

The values of the longitude of the node N and of the inclination J of the orbit of *Deimos*, in reference to the plane of the Earth's equator, employed in the following ephemeris, are

$$N = 49^\circ{\cdot}533, \qquad J = 36^\circ{\cdot}037.$$

The assumed proportion of the mass of the Sun to that of *Mars* is

$$\odot = 3095000.$$

The orbital longitude of *Deimos*, reckoned from the node, is

$$u_2 - 141^\circ{\cdot}43 + 285^\circ{\cdot}1616\,(t - t_0),$$

the epoch t_0 being 1886, March 14·0 Gr.

Phobos is assumed to move in the plane of the orbit of *Deimos*, and its longitude is taken to be

$$u_1 = 56^\circ{\cdot}54 + 1128^\circ{\cdot}8492\,(t - t_0),$$

its value being a little uncertain, as only two position-angles observed during the last opposition are available.

The periods of the sidereal revolutions corresponding to the assumed daily rates of motion are for

Phobos $7^h\ 39^m\ 13^s{\cdot}72$,

and for

Deimos $30^h\ 17^m\ 54^s{\cdot}99$.

a, b major and minor semi-axes of the apparent ellipses described by the satellites.

P position-angle of the minor axes.

U + 180° and B, areocentric longitude and latitude of the Earth referred to the plane of the orbit of *Deimos*, and reckoned from the node.

$u - U$ longitudes of the satellites, reckoned in their orbits from the points which are in superior conjunction with the planet's centre.

	Phobos.				*Deimos.*				
Greenwich Noon. 1886.	a_1	b_1	$u_1 - U$	P	a_2	b_2	$u_2 - U$	U	B
	″	″	°	°	″	″	°	°	°
Feb. 10	17·36	+ 6·68	158·98	22·13	43·43	+ 16·73	245·49	129·54	+ 22·65
11	17·48	6·72	208·09	22·02	43·74	16·83	170·89	129·32	22·62
12	17·60	6·76	257·21	21·91	44·05	16·93	96·30	129·08	22·60
13	17·72	6·80	306·34	21·79	44·35	17·03	21·72	128·82	22·58
14	17·84	6·84	355·49	21·66	44·65	17·13	307·16	128·56	22·55
15	17·96	6·88	44·65	21·53	44·93	17·22	232·60	128·28	22·53
16	18·07	6·92	93·82	21·39	45·21	17·31	158·06	127·99	22·51
17	18·18	6·95	143·00	21·24	45·48	17·40	83·53	127·69	22·48
18	18·28	6·98	192·19	21·09	45·74	17·48	9·02	127·37	22·46
19	18·38	7·02	241·39	20·93	46·00	17·56	294·51	127·05	22·44
20	18·48	7·05	290·60	20·77	46·24	17·63	220·01	126·71	22·42
21	18·57	7·07	339·81	20·60	46·47	17·70	145·53	126·37	22·39
22	18·66	7·10	29·04	20·42	46·69	17·77	71·05	126·01	22·37
23	18·74	7·12	78·27	20·24	46·89	17·83	356·58	125·64	22·35
24	18·82	7·15	127·51	20·06	47·08	17·88	282·12	125·27	22·32
25	18·89	7·17	176·76	19·87	47·26	17·94	207·67	124·89	22·30
26	18·96	7·19	226·02	19·67	47·44	17·99	133·22	124·50	22·28
27	19·02	7·20	275·28	19·47	47·60	18·03	58·78	124·10	22·26
28	19·08	7·21	324·55	19·27	47·74	18·06	344·35	123·70	22·23
Mar. 1	19·13	+ 7·23	13·82	19·06	47·86	+ 18·09	269·93	123·29	+ 22·21
2	19·17	7·24	63·09	18·85	47·97	18·12	195·51	122·88	22·19
3	19·21	7·24	112·36	18·64	48·06	18·14	121·09	122·46	22·17
4	19·24	7·25	161·64	18·42	48·14	18·15	46·67	122·04	22·15
5	19·26	7·25	210·92	18·20	48·21	18·16	332·26	121·62	22·12
6	19·28	+ 7·26	260·20	17·98	48·25	+ 18·16	257·85	121·19	+ 22·10
7	19·29	7·25	309·48	17·76	48·28	18·15	183·44	120·76	22·08
8	19·30	7·25	358·75	17·54	48·30	18·14	109·03	120·33	22·06
9	19·30	7·24	48·02	17·32	48·30	18·12	34·61	119·91	22·04
10	19·29	7·23	97·29	17·10	48·28	18·10	320·19	119·49	22·02
11	19·28	7·22	146·56	16·88	48·25	18·07	245·77	119·07	22·00
12	19·26	7·21	195·82	16·66	48·20	18·04	171·35	118·65	21·98

	Phobos.				*Deimos.*				
Greenwich Noon. 1886.	a_1	b_1	$u-U$	P	a_2	b_2	$u-U$	U	B
	″	″	°	°	″	″	°	°	°
Mar. 13	19·24	7·19	245·08	16·44	48·13	18·00	96·92	118·24	21·96
14	19·21	7·18	294·33	16·22	48·05	17·96	22·49	117·84	21·95
15	19·17	7·16	343·57	16·00	47·96	17·91	308·05	117·44	21·93
16	19·12	+ 7.14	32·80	15·79	47·85	+ 17·86	233·60	117·04	+ 21·92
17	19·07	7 11	82·03	15·58	47·72	17·80	159·15	116·65	21·90
18	19·01	7·09	131·25	15·37	47·58	17·74	84·69	116·27	21·89
19	18·95	7·06	180·45	15·17	47·43	17·67	10·22	115·90	21·88
20	18·89	7·03	229·65	14·97	47·27	17·60	295·74	115·53	21·87
21	18·82	7·00	278 84	14·78	47·09	17·53	221·25	115·18	21·86
22	18·74	6·97	328·01	14·59	46·90	17·45	146·76	114·83	21·85
23	18·66	6·94	17·18	14·41	46·70	17·37	72·25	114·50	21·84
24	18·58	6·91	66·33	14·23	46·49	17·29	357·73	114·17	21·84
25	18·49	6·88	115·47	14·06	46·27	17·21	283·20	113·86	21·83
26	18·40	6·84	164 60	13·89	46·04	17·12	208·65	113·56	21·83
27	18·30	6·81	213·71	13·73	45·80	17·03	134·10	113·27	21·83
28	18·20	6·77	262·81	13·57	45·55	16·94	59·53	112·99	21·83
29	18·10	6·73	311·90	13·42	45·29	16·85	344·95	112·73	21·83
30	18·00	6·69	0·98	13·28	45·03	16·75	270 36	112·48	21·84
31	17·89	6·66	50·04	13·15	44·76	16·66	195·75	112·24	21·85
Apr. 1	17·78	+ 6 62	99·08	13·02	44·48	+ 16·56	121·13	112·01	+ 21·86
2	17·67	6·58	148·11	12·90	44·20	16·47	46·50	111·80	21·87
3	17·55	6·54	197·13	12·79	43 91	16·37	331·85	111·60	21·88
4	17·43	6·50	246·13	12·69	43·62	16·27	257·19	111·42	21·90
5	17·31	6·46	295·12	12·59	43 32	16·17	182·51	111·25	21·9?
6	17·19	6·42	344·09	12·50	43·02	16·07	107·82	111·09	21·94
7	17·07	6·38	33·05	12·41	42·72	15·97	33·12	110·95	21·96
8	16 95	6·34	81·99	12·34	42·41	15 87	318·40	110·82	21·98
9	16·82	6·30	130 92	12·27	42·10	15·78	243·67	110·70	22·01
10	16·70	6·26	179·83	12·21	41·79	15 68	163·92	110·60	22·03
11	16 57	6·23	228·73	12·16	41·48	15·58	94·16	110·51	22 06
12	16·45	6·19	277·61	12·12	41·17	15·48	19·39	110·44	22·10
13	16·32	6·15	326·48	12·09	40·85	15·39	304·60	110 38	22·31
14	16·20	6·11	15·34	12·06	40 53	15·29	229·79	110·33	22 17
15	16·07	+ 6·07	64·18	12·04	40·22	+ 15·20	154 98	110·30	+ 22·21

These values are to be interpolated for the times for which the positions of the satellites are required, the equation of light having already been taken into account. The position-angles p and distances s are then to be found by means of the formulæ

$$s \sin (p - \mathrm{P}) = a \sin (u - \mathrm{U})$$
$$s \cos (p - \mathrm{P}) = b \cos (u - \mathrm{U}).$$

The satellites move in the direction of *in*creasing position-angles, and will be at their greatest eastern and western elongation (*e* in pos. P + 90° and *w* in pos. P − 90°) about the following Greenwich mean times :—

1886.	*Phobos.* h	*Deimos.* h		1886.	*Phobos.* h	*Deimos.* h	
Feb. 10	10·0 *w*	13·8 *e*	17·2 *e*	Mar. 12	9·2 *w*	13·0 *e*	8·3 *w*
11	12·8 *e*	16·6 *w*	8·3 *w*	13	12·0 *e*	15·8 *w*	14·5 *w*
12	11·7 *e*	15·6 *w*	14·6 *w*	14	11·0 *e*	14·8 *w*	5·7 *e*
13	10·7 *e*	14·5 *w*	20·9 *w*	15	9·9 *e*	13·7 *w*	11·9 *e*
14	13·5 *w*	17·3 *e*	12·0 *e*	16	12·7 *w*	16·5 *e*	18·2 *e*
15	12·4 *w*	16·3 *e*	18·3 *e*	17	11·6 *w*	15·5 *e*	9·3 *w*
16	11·4 *w*	15·2 *e*	9·4 *w*	18	10·6 *w*	14·4 *e*	15·6 *w*
17	10·3 *w*	14·2 *e*	15·7 *w*	19	9·5 *w*	13·4 *e*	6·7 *e*
18	13·1 *e*	17·0 *w*	6·8 *e*	20	12·3 *e*	16·2 *w*	13·0 *e*
19	12·1 *e*	15·9 *w*	13·1 *e*	21	11·3 *e*	15·1 *w*	19·2 *e*
20	11·0 *e*	14·9 *w*	19·3 *e*	22	10·2 *e*	14·1 *w*	10·3 *w*
21	13·8 *w*	17·6 *e*	10·5 *w*	23	9·2 *e*	13·0 *w*	16·6 *w*
22	12·8 *w*	16·6 *e*	16·7 *w*	24	12·0 *w*	15·8 *e*	7·8 *e*
23	11·7 *w*	15·6 *e*	7·8 *e*	25	10·9 *w*	14·8 *e*	14·0 *e*
24	10·7 *w*	14·5 *e*	14·1 *e*	26	9·9 *w*	13·7 *e*	5·2 *w*
25	13·5 *e*	17·3 *w*	20·4 *e*	27	8·8 *w*	12·7 *e*	11·4 *w*
26	12·4 *e*	16·2 *w*	11·5 *w*	28	11·6 *e*	15·4 *w*	17·7 *w*
27	11·4 *e*	15·2 *w*	17·8 *w*	29	10·6 *e*	14·4 *w*	8·8 *e*
28	10·3 *e*	14·1 *w*	8·9 *e*	30	9·5 *e*	13·4 *w*	15·1 *e*
Mar. 1	13·1 *w*	16·9 *e*	15·1 *e*	31	8·5 *e*	12·3 *w*	6·2 *w*
2	12·0 *w*	15·9 *e*	6·3 *w*	Apr. 1	11·3 *w*	15·1 *e*	12·5 *w*
3	11·0 *w*	14·8 *e*	12·5 *w*	2	10·2 *w*	14·1 *e*	18·8 *w*
4	13·8 *e*	17·6 *w*	18·8 *w*	3	9·2 *w*	13·0 *e*	9·9 *e*
5	12·7 *e*	16·6 *w*	9·9 *e*	4	8·2 *w*	12·0 *e*	16·2 *e*
6	11·7 *e*	15·5 *w*	16·1 *e*	5	11·0 *e*	14·8 *w*	7·4 *w*
7	10·6 *e*	14·5 *w*	7·3 *w*	6	9·9 *e*	13·7 *w*	13·6 *w*
8	13·4 *w*	17·2 *e*	13·5 *w*	7	8·9 *e*	12·7 *w*	4·8 *e*
9	12·4 *w*	16·2 *e*	19·8 *w*	8	7·8 *e*	11·6 *w*	11·1 *e*
10	11·3 *w*	15·1 *e*	10·9 *e*	9	10·6 *w*	14·4 *e*	17·4 *e*
11	10·3 *w*	14·1 *e*	17·2 *e*	10	9·6 *w*	13·4 *e*	8·5 *w*